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SEPTEMBER 1956 VOL. LI. NO. 9

FIFTY-FIRST YEAR OF PUBLICATION

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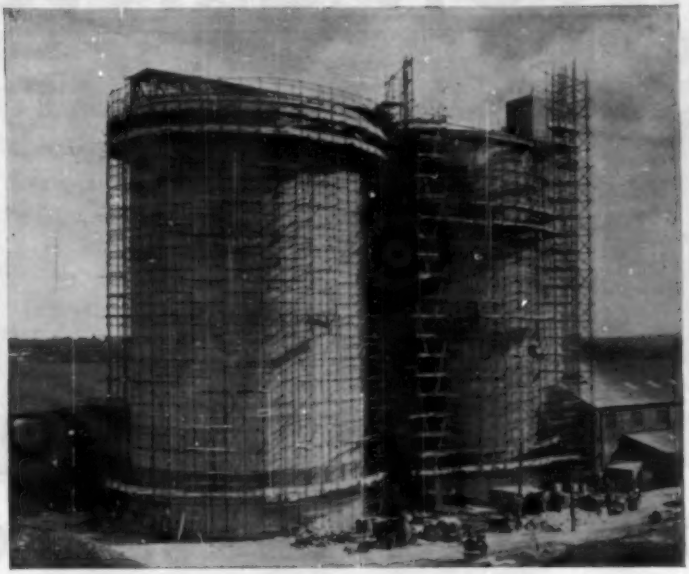

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These two storage silos for the British Sugar Corporation rise 110 feet and have a total capacity of 15,000 tons. They are 66 feet in diameter and the walls, which are eight inches thick, are in prestressed concrete. Construction of the silo walls was carried out with sliding shutters lifted at an average rate of 9¾" an hour by 40 hydraulic jacks operated from a central pump. Prestressing was by the Gifford Udall system with 0.276" diameter wires outside the main walls, protected by coating with Gunite.

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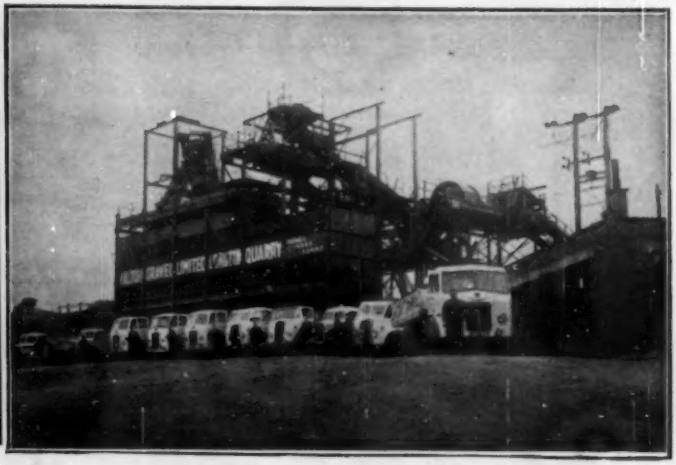

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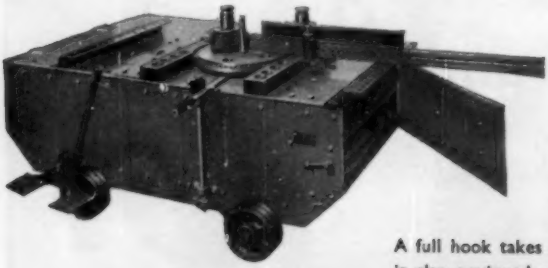

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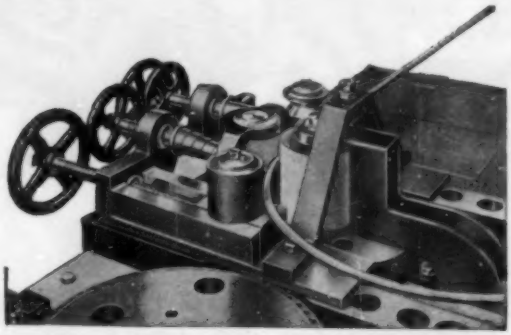

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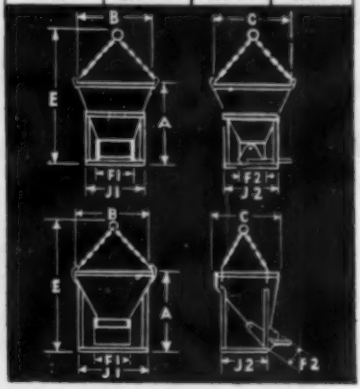

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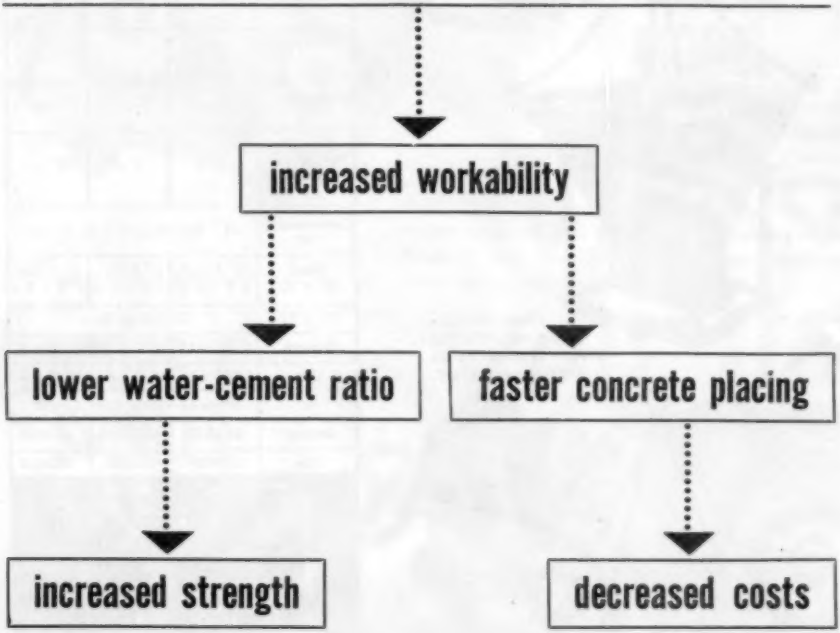

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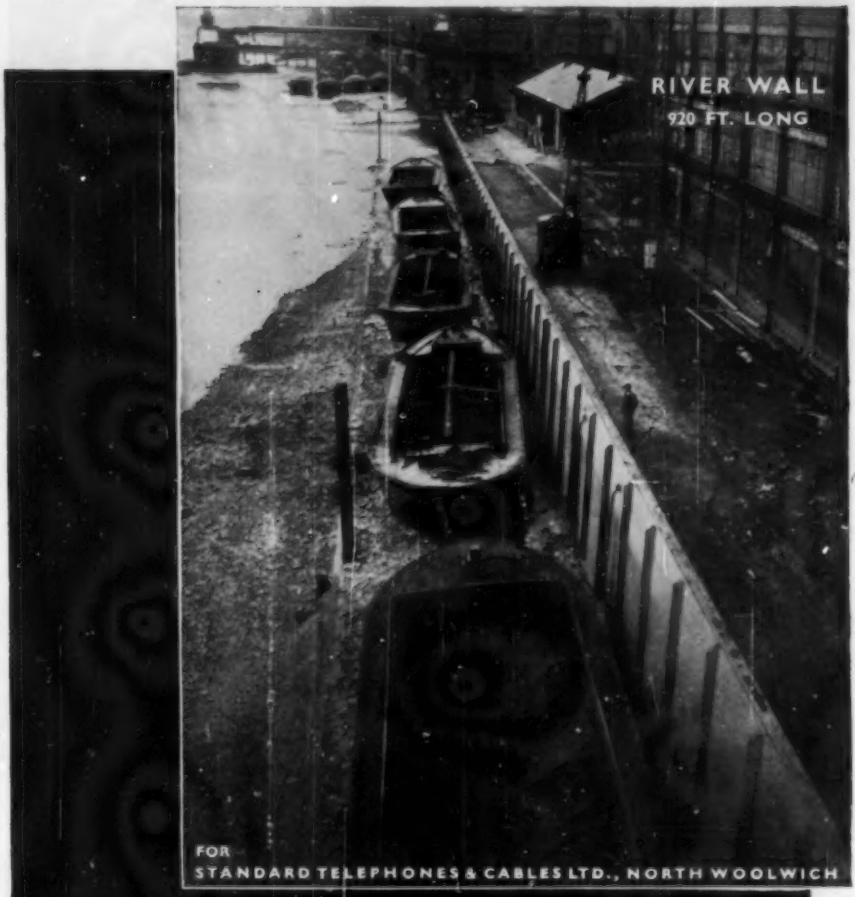

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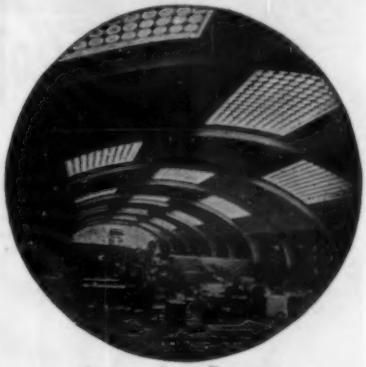

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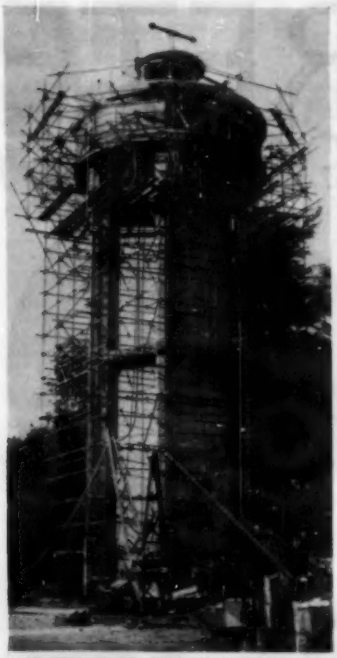

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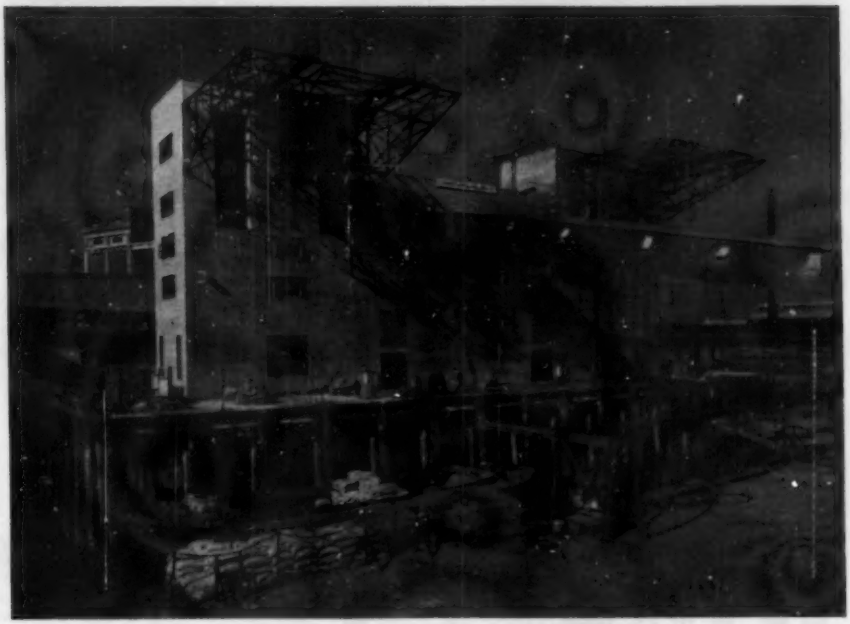

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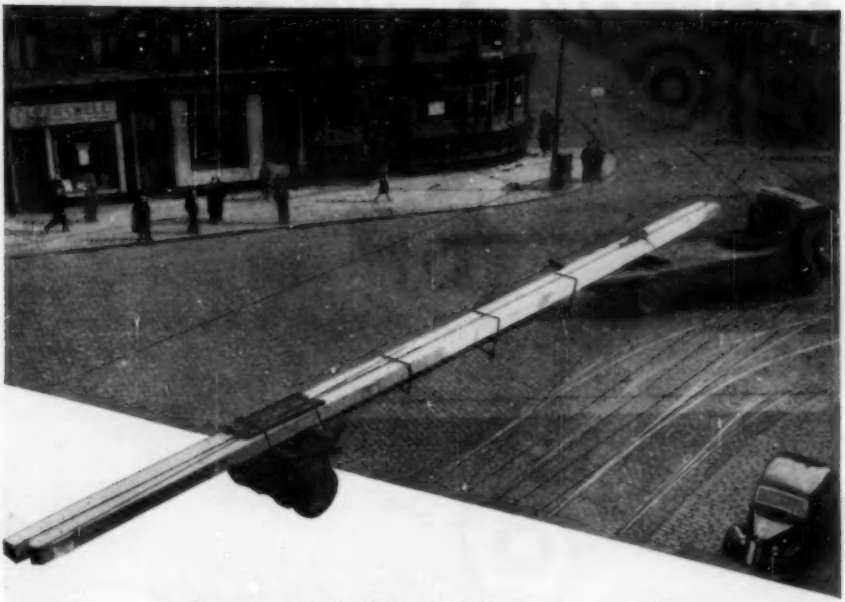

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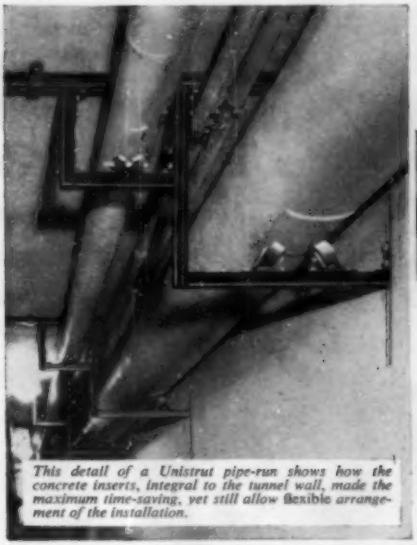

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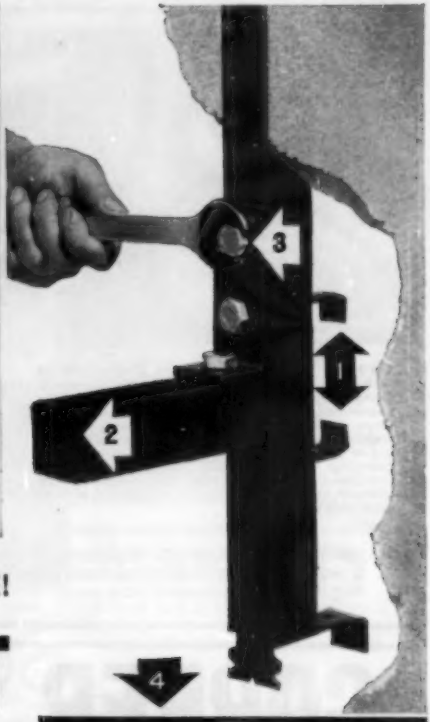

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ALLT-NA-LAIRIGE PROJECT

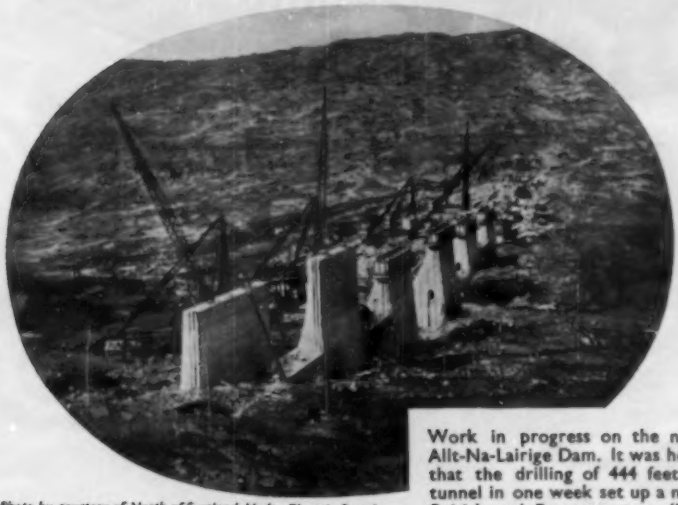

Photo by courtesy of North of Scotland Hydro Electric Board.
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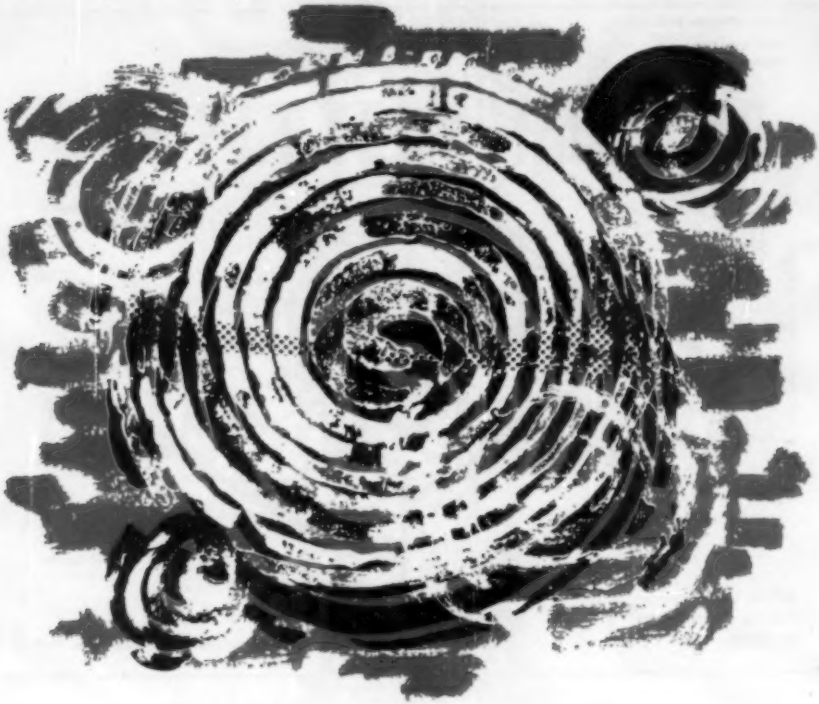

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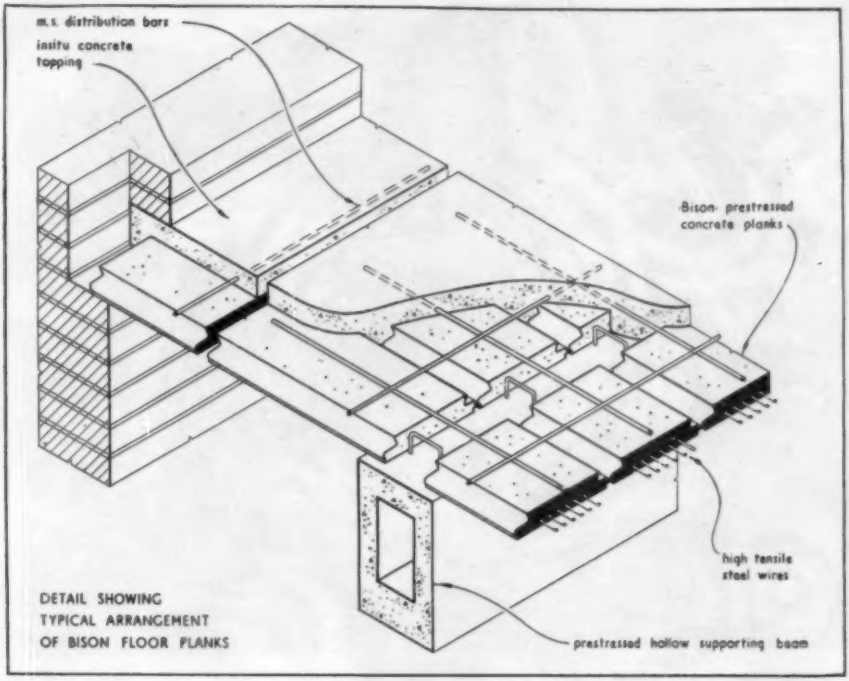

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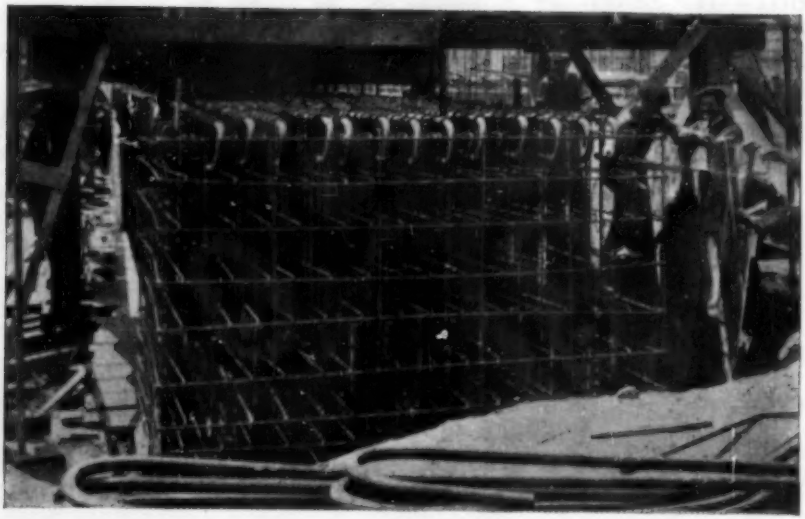
REINFORCING
BARS



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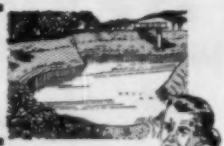

CATHEDRAL FOUNDATIONS
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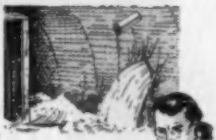
SEA BREAKS INTO
MAIN SEWER



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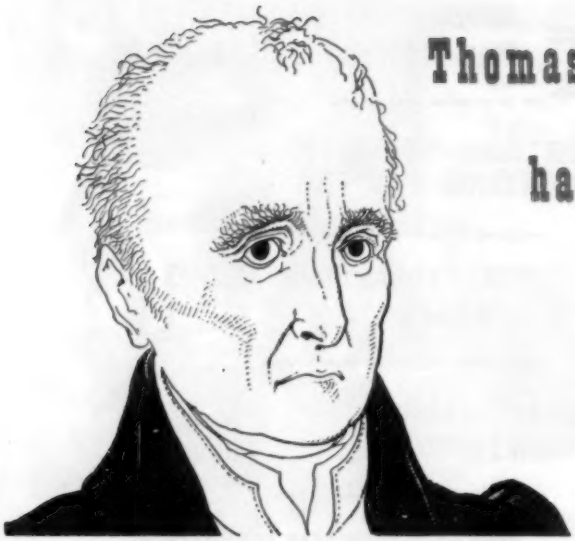

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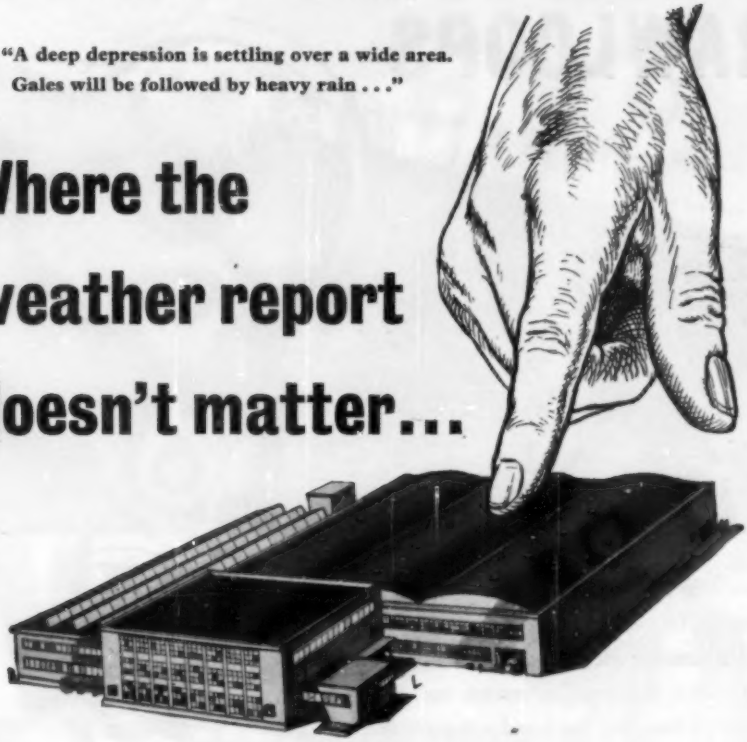

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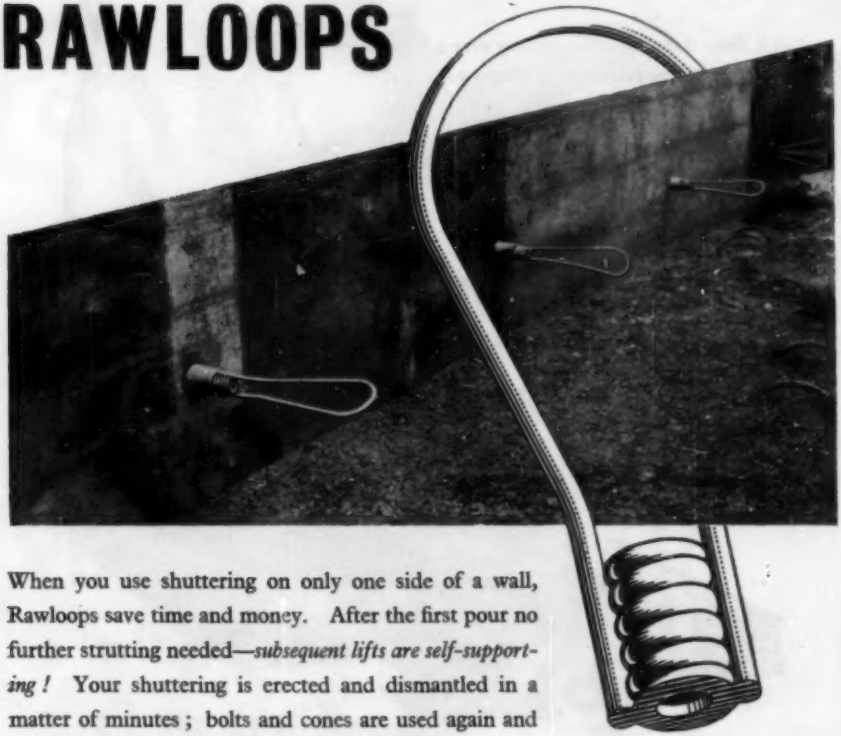

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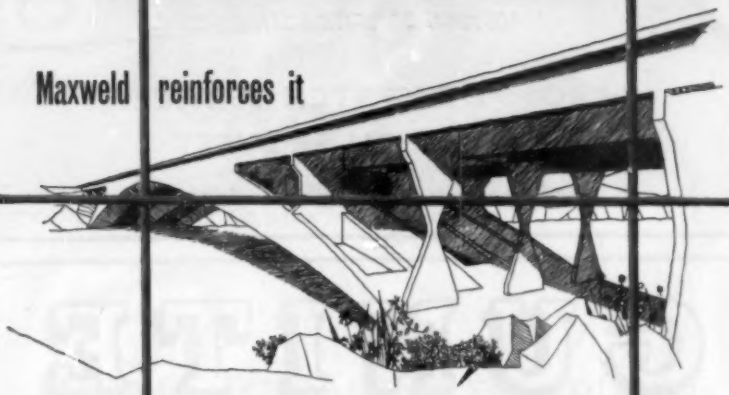

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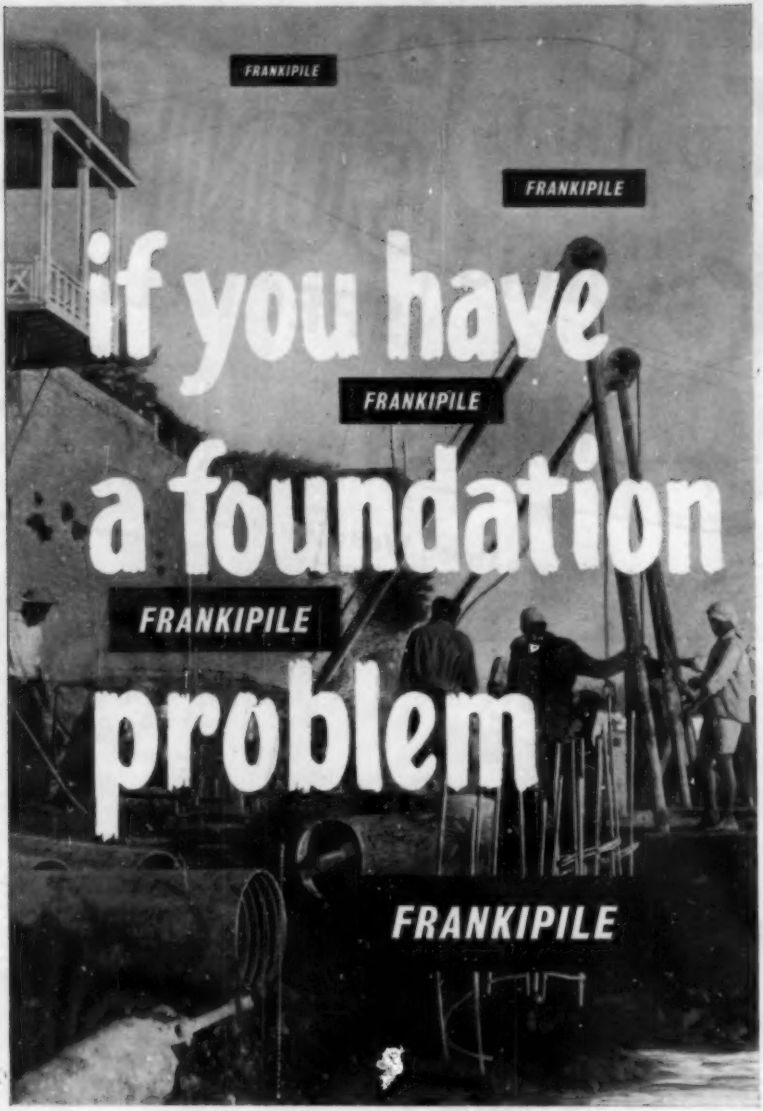

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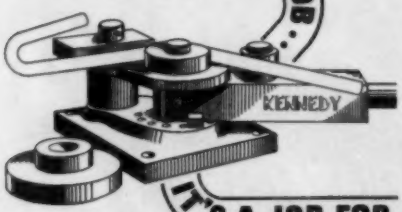

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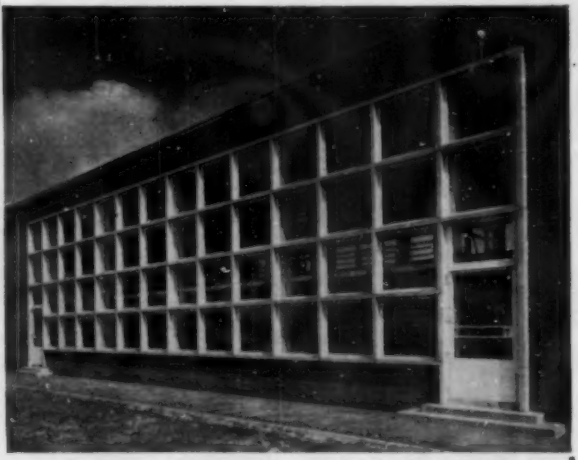

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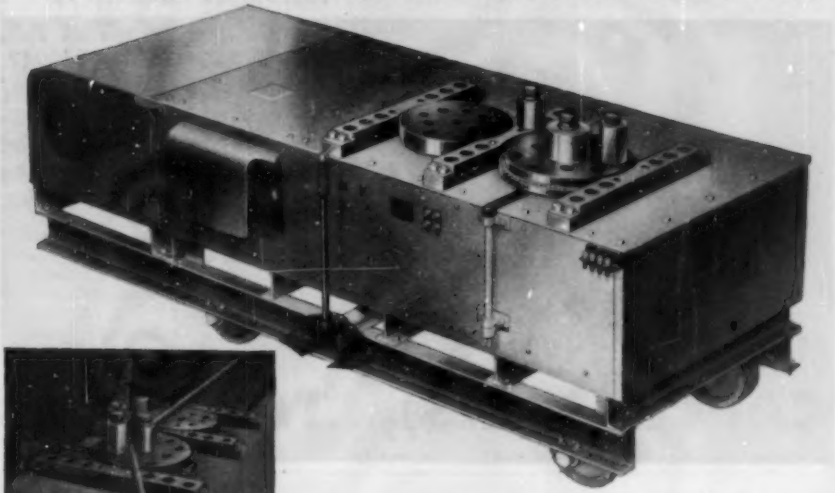

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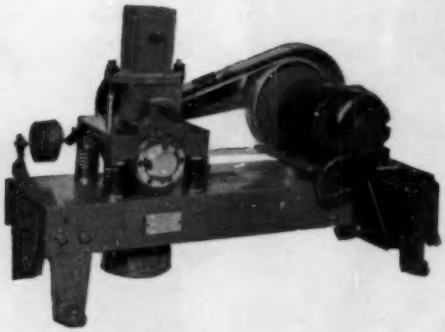

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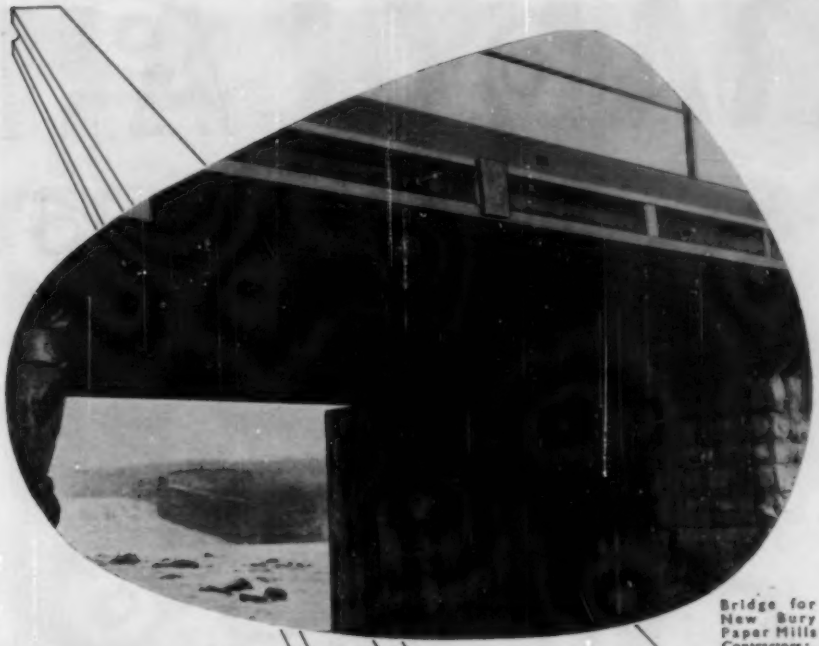

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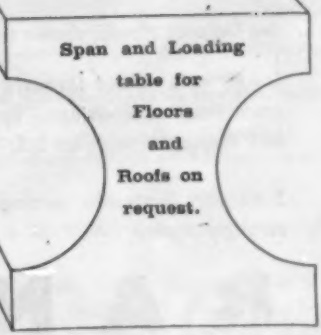

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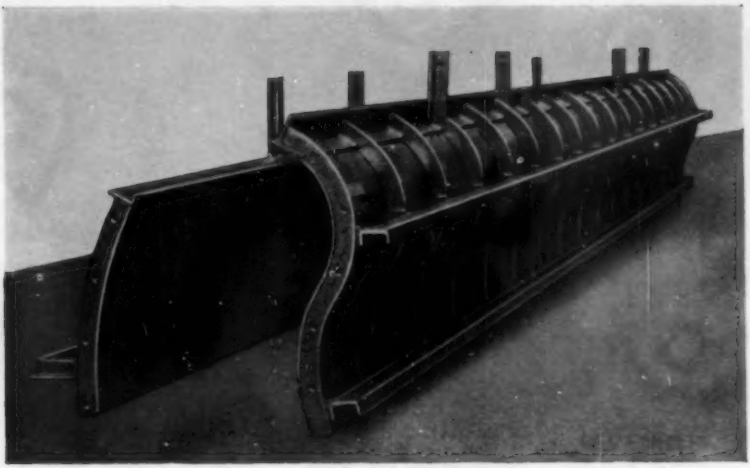

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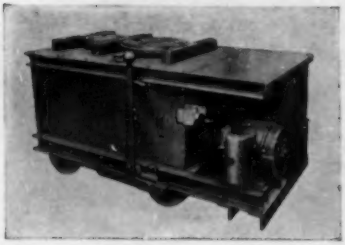
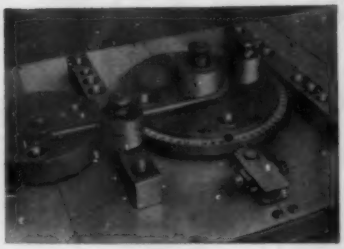


The LACO power-operated Bar Bender will handle round bars up to 1¼" diameter. Several bars can be bent simultaneously according to the diameter of the material.



Main Features:

Two Turntables revolve simultaneously, the fast Turntable at more than 10 r.p.m., enabling a 1" hook to be bent in 3 seconds; the slow Turntable at 2½ r.p.m. will bend a 1½" hook in 12 seconds.

Feeding: Bars are fed into the machine from left or right. Hooks are made clockwise or counterclockwise. Flexibility of the machine ensures minimum handling of the bar during operation. **This saves time.**

Automatic Stop: Turntables can be set to stop automatically at any angle to an accuracy of ½°. Identical bends are repeatedly obtained.

All gears steel and precision cut, pinions of heat-treated alloy steel. All shafts, even the slowest, fitted with grease-packed ball bearings.

Ease of control: One control only. Hand lever integral with foot pedal for operating machine in either direction.

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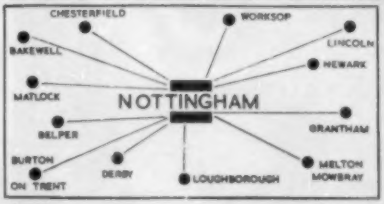

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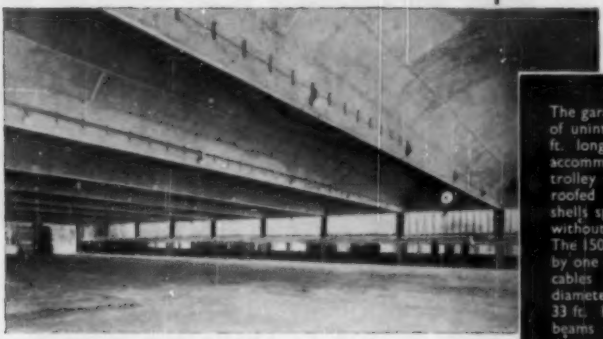

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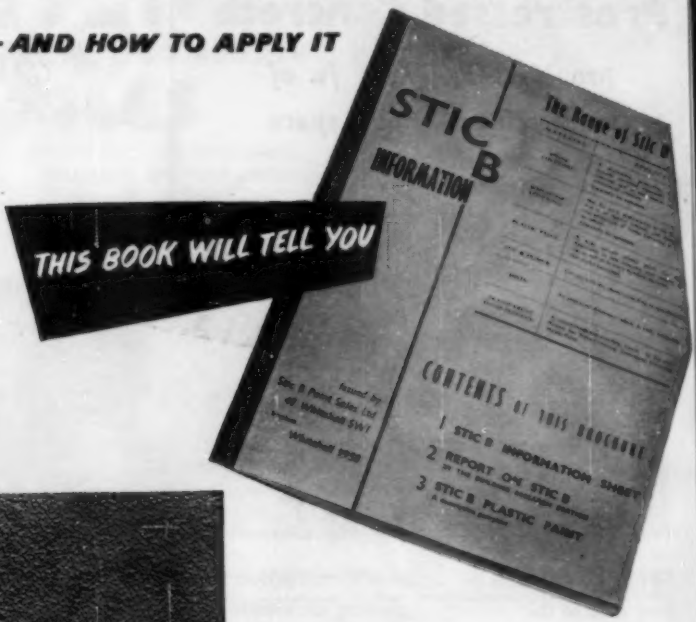
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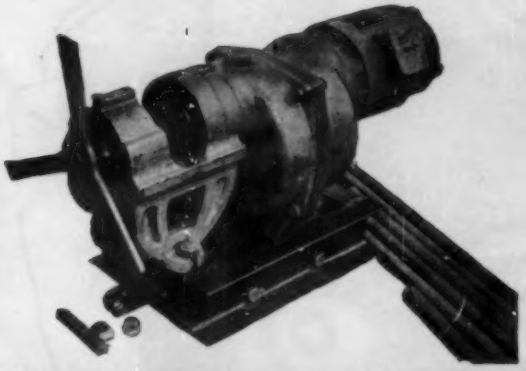

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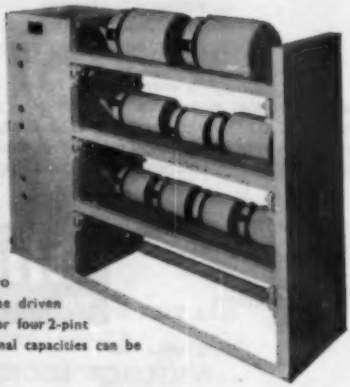

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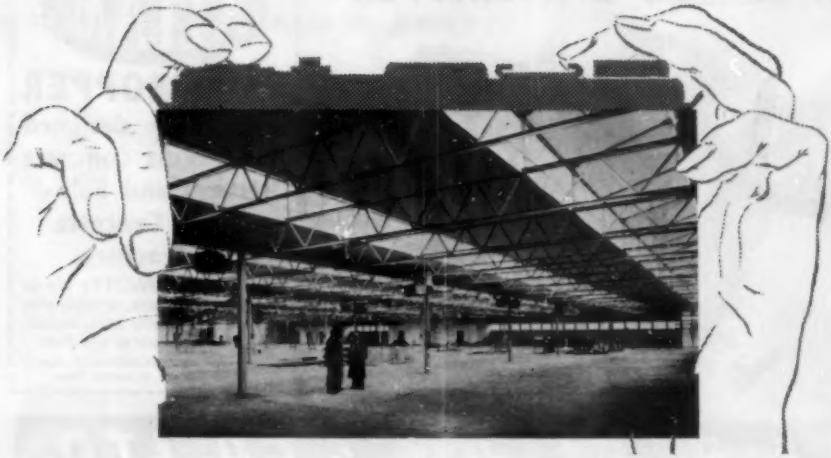

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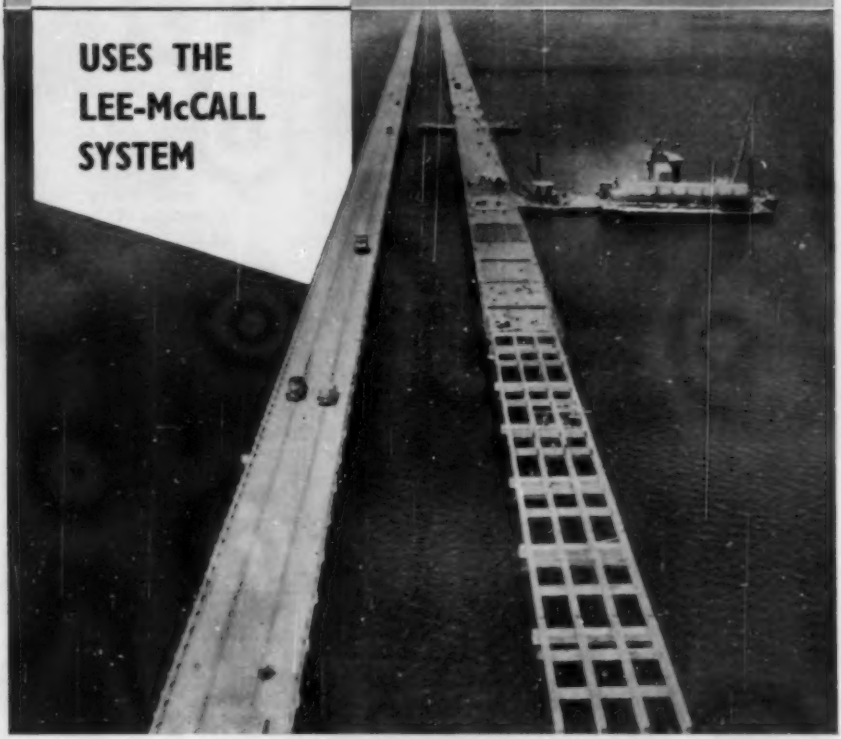

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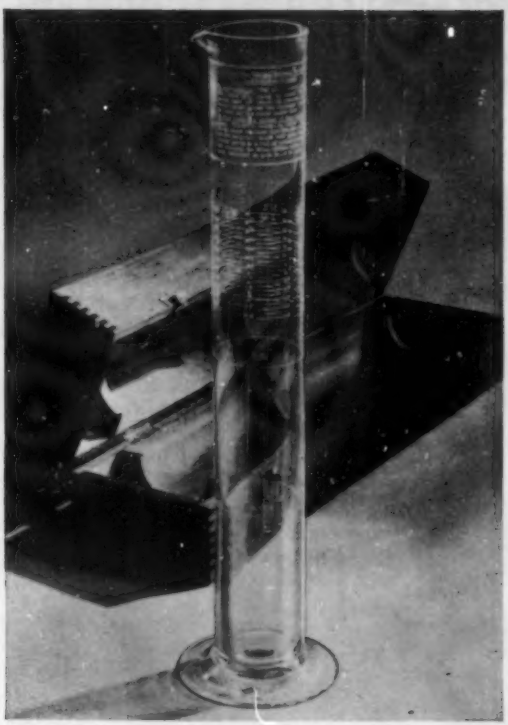

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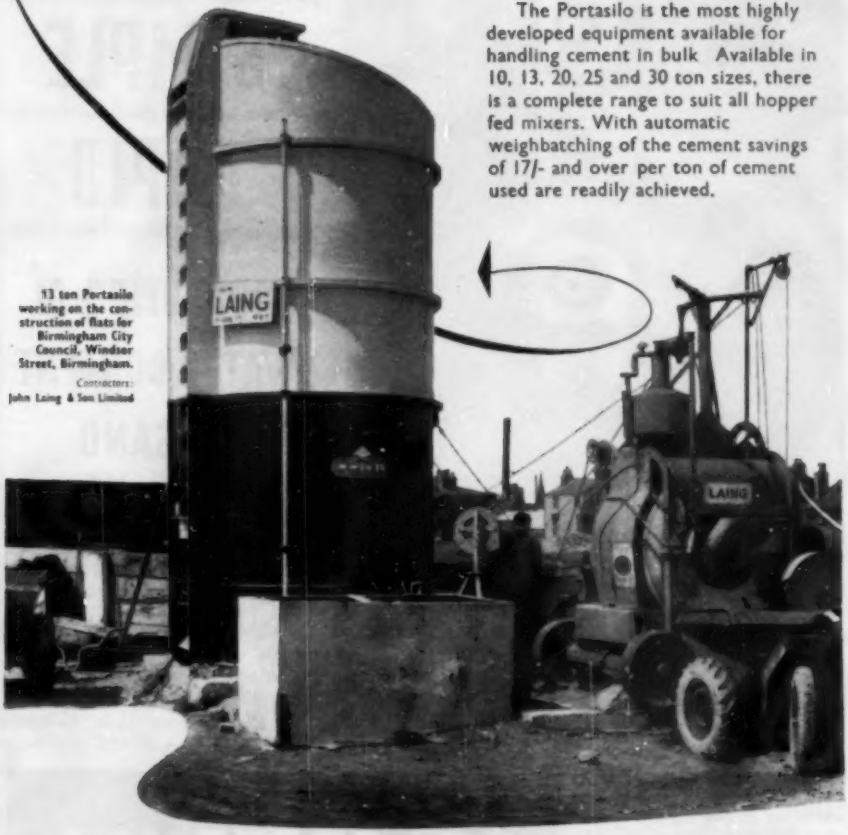

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EDITORIAL NOTES

Design Based on Loads Causing Failure.

EARLY designers of reinforced concrete structures used methods based on the ultimate strength of the members, but the theoretical attractions of analysis based on a " straight-line " relationship between stress and strain (the " elastic " theory) obscured for many years the advantages of the original conceptions. It has, however, been found from tests of separate members and complete structures that the elastic method does not enable the load causing failure of a structure to be determined with accuracy. In certain cases " elastic " analysis will predict the breaking strength fairly closely, as in the case of under-reinforced beams ; in other cases, notably doubly-reinforced beams and columns, the method leads to under-valuation of the strength. This is not to say that the application of the theory of elasticity to reinforced concrete is necessarily invalid, but rather that its use to predict a factor of safety against failure is an incorrect application of the theory, as the material must be stressed beyond its elastic limit before failure occurs.

In recent years much has been published on methods of design based on " ultimate " strength, most of which differ only in the assumed distribution of the compressive stress. Fortunately this does not appear to be of great practical significance as, when expressed in the same terms, most of the methods give comparable results in the common cases of members subjected to bending only or to compression only. For many years codes of practice, including those of this country, have recognised that the use of a modular-ratio in designing columns is incorrect, and have recommended an ultimate-load method for the design of columns only. Thus there is an inconsistency in the codes of practice which recommend ultimate-load methods for columns but elastic methods for beams, due to the fact that beams are one extreme, and axially-loaded columns the other extreme, of the general case of bending combined with axial load. Further complications are caused by the adjustments to maximum bending moments allowed in the British code and the concession in the code of the American Concrete Institute allowing compressive reinforcement in beams to have twice the value indicated by the elastic theory ; both are partial recognitions of the plastic redistribution of compressive stresses in concrete.

In some countries, including Brazil, Poland, Austria, Czechoslovakia, and the

U.S.S.R., the regulations recognise, and in some cases insist on, the use of ultimate-load methods of design. Recently a European committee on the design of reinforced concrete was set up due to the efforts of French engineers, and an attempt is being made to unify design on the Continent on the basis of ultimate-load methods. In this country the revisions now being made to the British Standard Code of Practice for the Structural Use of Normal Reinforced Concrete in Buildings are expected to permit an ultimate-load method as an alternative to the elastic method, and the draft recommendations for the revision of the code of the American Concrete Institute include similar provisions. In the revised British code it is expected that an attempt will be made to present the method in a manner so that the calculations are of the same form as those for elastic analyses, that is the load factors will be applied to the stresses and the calculations related to the working loads as is normally done. A factor of safety of two against failure of the steel and three against failure of the concrete has been proposed ; the higher load-factor against crushing of the concrete is required because of the undesirability of sudden collapse without the warning that is typical of failures that originate by cracking of the concrete. The method proposed in the American code requires the use of a load-factor varying with the conditions of loading and the need or otherwise to consider the effects of loads due to wind and earthquake ; the actual loads are then multiplied by these factors and the size of the member determined from expressions predicting its ultimate strength in terms of the crushing strength of the concrete and the yield-point strength of the steel. In both cases the factor of safety of the structure is about two. It is not likely that either the British or U.S.A. codes will give guidance on the ultimate strength of a member subjected to shearing forces, and it may be assumed that shearing resistance is to be provided on the lines indicated by the elastic methods.

It is not to be expected that the adoption of the proposed method will lead to a general reduction in the sizes of members or in the amount of reinforcement required. Less reinforcement may be used in doubly-reinforced beams and in columns subjected to combined bending and compression ; in the case of singly-reinforced beams, however, it is likely that the slightly smaller sections shown to be sufficient will need more tensile reinforcement than sections designed by the elastic method for the same loads. Nevertheless, the reduction or omission of steel to resist compressive forces at supports and reduction of the amount of reinforcement in the columns of framed structures allow arrangements of reinforcement that enable better consolidation of the concrete to be obtained at positions subjected to greatest stress. Whatever the immediate apparent savings that can be made it can, however, be shown that the ultimate-load method enables a more precise estimate to be made of the factor of safety of a particular structure and to predict the behaviour of structures as shown by tests.

However, a difficulty in the use of a load-factor method is the choice of the correct factors relating the probability of overload to working load ; this is obvious in the method recommended in the U.S.A. code, but it is just as important in the method proposed in the British code although obscured by an indirect approach. Similar difficulties are present in determining safe limits for working stresses in relation to stresses at failure, particularly with a material so lacking in uniformity as concrete. Some enthusiastic advocates of the new method of design have made very exaggerated claims about the uniformity of concrete, which

are quite at variance with the common experience of wide differences in the strength of works test cubes of concrete made with all the refinements introduced by the "mix designers". These difficulties apply to all methods of design, but with ultimate-load methods they are brought immediately to the fore. Statistical analyses based on careful observation may lead to a reasonable estimation of the loads, and this work could well be done by official research organisations as was done during the preparation of the report of the Steel Structures Research Committee. Where the proposed methods show that smaller members may be used than are generally now adopted it is advisable to ensure that deflections will not be excessive at working loads, and simple guides such as the ratios of span to depth would then have to be used in conjunction with elastic analyses.

A recent publication* describes ultimate-load methods that will be of use to all who wish to become conversant with this method of design. The methods are also applicable to prestressed concrete, with which it is more essential than with reinforced concrete to ensure that there is a sufficient factor of safety against failure. This is not to say that prestressed concrete is in itself more likely to fail than reinforced concrete, but the accumulation of experience that guides designers in reinforced concrete is not yet available in the case of prestressed concrete. A reliable method of calculating the factor of safety of prestressed concrete would certainly lead to its wider adoption by some who may still be unwilling to incur the risks associated with a relatively new material. In addition to a method for the design of sections, the book gives a considerable amount of information on the plastic-hinge theory for the design of frames. This is comparable to the methods evolved for the design of steel frames, and it is believed that this is the first book dealing with the subject applied to reinforced concrete. The theory presented will, it is believed, considerably simplify the analysis of frames with many redundant members or joints and lead to a consistent basis of design with adequate and uniform factors of safety.

The author deals at some length with the matters that have to be considered in deciding upon a suitable factor of safety for any particular structure, and gives recommendations which are related to the possible results of failure. These recommendations range from a factor of safety of two in the case of a structure whose failure might result in loss of life or the destruction of valuable goods or machinery to a factor of safety of 1·45 for a precast concrete structure built in a sheltered position and used only for the storage of materials that would not be harmed if the building collapsed. The matters to be considered in deciding the factor include, in addition to the results of failure, the quality of the workmanship, the conditions of loading, the importance of the member in the structure, and the possible loss of strength with time due to exposure to the elements or to the nature of the contents, and recommendations are given on the relative importance of these and other factors that may be expected to influence the strength and stability of a structure.

* "The Ultimate-load Theory Applied to the Design of Reinforced and Prestressed Concrete Frames", by Professor A. L. L. Baker. (Concrete Publications, Ltd. London. 1956. Price 18s.)

A Bridge Deck on Prestressed Planks.

THE following notes on a road bridge with a span of 19 ft. 8 in. and a width of 32 ft. 6 in. built in Poland in 1953 are abstracted from " Inzynieria i Budownictwo " for January 1956.

The tensile forces in the deck slab are resisted by prestressed concrete " planks " spanning between the abutments and which also served as centering. Two layers of these planks are used, the upper layer being at right angles to the lower layer (*Figs.* 1 and 2). To improve the bond with the concrete cast on top of the planks, steel stirrups of 4·5 mm. ($\frac{1}{16}$ in.) diameter were cast in the top of the lower planks (*Fig.* 3). The planks in the bottom layer, measuring $6\frac{3}{4}$ in. wide by $1\frac{1}{8}$ in. thick, are placed close together; in the top layer the planks (*Fig.* 4) are 4 in. wide by $1\frac{1}{8}$ in. thick and are placed at 15 in. centres. The two layers were not mortared together. About 1·1 lb. of steel was used per square foot of the deck. Prestressed members (*Fig.* 5) measuring $2\frac{3}{4}$ in. by $1\frac{1}{4}$ in. were used for handrail posts.

Owing to the novel form of construction the bridge was tested three times to measure the deflection of the slab at different temperatures. The tests were all made with a load of about 22 tons due to the rear axles of two lorries. In the first test, made in the autumn of 1953, the maximum deflection was 0·01457 in. The second test was made in the winter of 1954 at a temperature of 3 deg. Fahr. and the maximum deflection was 0·00591 in. When tested in the summer of 1954 the deflection was 0·00748 in. The ratio of deflection to span varied from about 1 in 16,000 to 1 in 40,000.

During the last test measurements were also made of the deflection due to a dynamic load. A board $2\frac{3}{4}$ in. thick was laid across the bridge and the impact was provided by a lorry passing over it at 30 miles per hour. The deflection due to the dynamic load was about 16 per cent. greater than that due to the static load. When the board was removed the deflection due to the load moving across the bridge was about 4 per cent. less than when the load was stationary.

A similar type of slab was made and tested at the experimental centre of the Institute of Building Technique in Poland

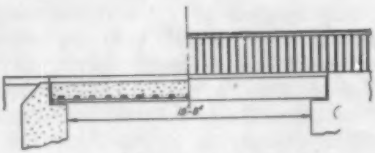


Fig. 1.—Longitudinal Section.

Fig. 2.—Transverse Section.

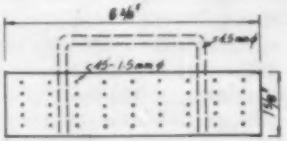


Fig. 3.

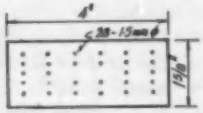


Fig. 4.—Cross Section through Plank.

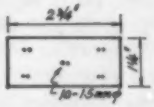


Fig. 5.—Cross Section through Handrail Post.

and was reported in a paper by Mgr. Inz. Wiktor Grzegorzewski. The results showed that the strength of such a slab supported on four sides depends upon the sum of the moments of resistance of the planks in both directions and not upon the moment of resistance of any one of them.

Bending Moments at the Supports of Continuous Beams.

A New "Fixed-point" Solution.

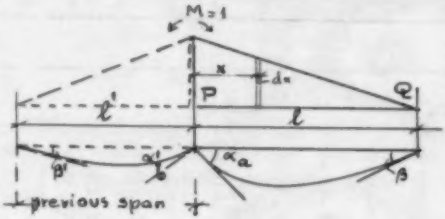
By L. A. ALTING MEES, B.Sc., A.M.S.A.I.C.E.

AN alternative method is given for calculating the bending moments on continuous beams and which enables the maximum ordinate of the influence line to be obtained.

A convenient expression for the carry-over factor (c) is given in *Table* I; it contains only the angular deflections α and β due to a unit bending moment

TABLE I.

CARRYOVER FACTORS (c)



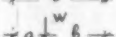
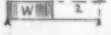
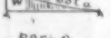
$\alpha, \beta, \alpha', \beta'$ = angular defl. due to mom. M=1 at end of freely supp. span.

1	Mom. of inertia (I) constant for whole beam.	$c_\ell = \dfrac{\frac{1}{2}\ell}{\ell + \ell' - \frac{1}{2}\ell' c'}$ *
2	Mom. of inertia (I) constant per span	$c_\ell = \dfrac{\frac{1}{2}\ell/I}{\ell/I + \ell'/I' - \frac{1}{2}\ell'/I' c'}$
3	Mom. of inertia (I) varying.	$c_\ell = \dfrac{\beta}{\alpha_a + \alpha'_\ell - \beta' c'_\ell}$
4	For frame with sway prevented and mom. of inertia varying.	$c_\ell = \dfrac{\beta}{\alpha_a + \dfrac{1}{\Sigma \dfrac{1}{\alpha'_\ell - \beta' c'_\ell}}}$
5	Beam end partly fixed	$c = \frac{1}{2} \times$ fixing degree

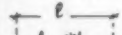
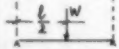
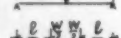
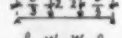
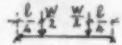
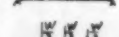
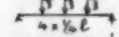
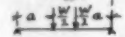
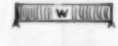
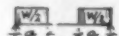
* c_l is the carry-over factor to the left in span l and c' the carry-over factor to the left in span l'.

TABLE II.

SUPPORT MOMENTS FOR TOTAL LOAD W ON PRISMATIC SPAN. (ALL OTHER SPANS BEING UNLOADED).

		LEFTHAND MOMENT M'	RIGHTHAND MOMENT M''
1		$-\frac{ab}{\ell^2}\frac{i}{5}(\ell+b-3k)\,W$	$-\frac{ab}{\ell^2}\frac{k}{5}(\ell+a-3i)\,W$
2		$-\frac{1}{2}\frac{i}{5}\left(\frac{8}{15}\ell-k\right)W$	$-\frac{1}{2}\frac{k}{5}\left(\frac{7}{15}\ell-i\right)W$
3		$-\frac{1}{2}\frac{i}{5}\left(\frac{9}{16}\ell-k\right)W$	$-\frac{1}{2}\frac{k}{5}\left(\frac{7}{16}\ell-i\right)W$
4		$-\frac{1}{2}\frac{i}{5}\frac{a(3\ell-2a)}{\ell^2}\left[\frac{(2\ell-a)^2}{2(3\ell-2a)}-k\right]W$	$-\frac{1}{2}\frac{k}{5}\frac{a(3\ell-2a)}{\ell^2}\left[\frac{2\ell^2-a^2}{2(3\ell-2a)}-i\right]W$
5		$-\frac{9}{20}\frac{i}{5}\left(\frac{7}{12}\ell-k\right)W$	$-\frac{9}{20}\frac{k}{5}\left(\frac{5}{12}\ell-i\right)W$
6		$-\frac{21}{40}\frac{i}{5}\left(\frac{15}{28}\ell-k\right)W$	$-\frac{21}{40}\frac{k}{5}\left(\frac{13}{28}\ell-i\right)W$
7		$-\frac{1}{4}\frac{i}{5}\frac{12ab-d^2}{\ell^2}\left[\frac{\ell\{4a(\ell+\ell)-d^2\}}{12ab-d^2}-k\right]W=M'$	$-\frac{1}{4}\frac{k}{5}\frac{12ab-d^2}{\ell^2}\left[\frac{a\{4b(\ell+a)-d^2\}}{12ab-d^2}-i\right]W=M''$

Moments tending to produce tension in the underside of the beam are assumed to be positive.

		M' (lefthand) = ↓	For M'' interchange i and k in formulae for M' ↔ $\frac{i}{5}$ $\frac{k}{5}$
8		$-\frac{3}{8}\frac{i}{5}(\ell-\frac{1}{2}k)\,W$	
9		$-\frac{1}{3}\frac{i}{5}(\ell-2k)\,W$	
10		$-\frac{9}{32}\frac{i}{5}(\ell-2k)\,W$	
11		$-\frac{5}{16}\frac{i}{5}(\ell-2k)\,W$	
12		$-\frac{3}{2}\frac{i}{5}\frac{a(\ell-a)}{\ell^2}(\ell-2k)\,W$	
13		$-\frac{1}{4}\frac{i}{5}(\ell-2k)\,W$	
14		$-\frac{1}{4}\frac{i}{5}\frac{2a(3\ell-2a)}{\ell^2}(\ell-2k)\,W$	
15		$-\frac{1}{4}\frac{i}{5}\frac{3\ell^2-b^2}{\ell^2}(\ell-2k)\,W$	
16		$-\frac{5}{16}\frac{i}{5}(\ell-2k)\,W$	
17		$-\frac{1}{4}\frac{i}{5}\frac{\ell^2+\ell a-a^2}{\ell^2}(\ell-2k)\,W$	
18		$-\frac{17}{64}\frac{i}{5}(\ell-2k)\,W$	
19		$-\frac{3}{10}\frac{i}{5}(\ell-2k)\,W$	

applied at one end of a freely-supported beam. The carry-over factors are calculated successively from each end of a beam. The effect of a fixed end is obtained by assuming that there is an imaginary beam with a span of length $l = 0$ (or $I = \infty$) extending beyond the fixed end, and similarly for a freely-supported end by assuming that there is an imaginary beam of span $l = \infty$ (or $I = 0$) extending beyond the freely-supported end.

Support Moments.

In the main there are three methods of calculating bending moments, namely, by direct solution (Pirlet, Magnel, Leutkens, and others), by relaxation methods (Hardy Cross and Southwell), and by the methods (Suter, Efsen, Shepley, Dischinger, Magnel, and others) in which the properties of the beam are first assessed and these properties are then substituted in a formula giving the bending moments at the supports of a loaded span, all other spans being unloaded.

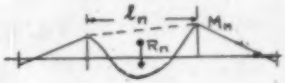
With regard to the third method it is considered that the moments can more easily be obtained by the solution given in *Fig.* 1, namely,

$$M_l = -\frac{1}{\beta}\frac{i}{s}R\left(\frac{g_r - k}{l}\right) \quad . \quad . \quad . \quad . \quad (1a)$$

$$M_r = -\frac{1}{\beta}\frac{k}{s}R\left(\frac{g_l - i}{l}\right). \quad . \quad . \quad . \quad . \quad (1b)$$

wherein M_l and M_r are the support moments at the left and right ends respectively of the beam, all other spans being unloaded ; l is the span of the beam considered ; i is the distance of the left-hand fixed point from the left-hand support ; k is

$$M_n = -\frac{R_n \frac{g_{rn}}{l_n}\Delta_{n(n-1)} + R_n \frac{g_{ln}}{l_n}\Delta_{nn}}{\Delta}$$



$$M_n\left[\beta_n \Delta_{n(n-1)} + (\alpha_n + \alpha_{n+1})\Delta_{nn} + \beta_{n+1}\Delta_{n(n+1)}\right] = -\frac{R_n}{l_n}\left[(l_n - g_{ln})\Delta_{n(n-1)} + g_{ln}\Delta_{nn}\right]$$

$$M_n \beta_n\left[\frac{\Delta_{n(n-1)}}{\Delta_{nn}} + \frac{\alpha_n + \alpha_{n+1}}{\beta_n \Delta_{nn}} + \frac{\beta_{n+1}}{\beta_n}\frac{\Delta_{n(n+1)}}{\Delta_{nn}}\right] = -\frac{R_n}{l_n}\left[(l_n - g_{ln})\frac{\Delta_{n(n-1)}}{\Delta_{nn}} + g_{ln}\right]$$

Because the ratio between the subdeterminants concerned equals minus times the carryover factors,

$$M_n \beta_n\left[-\frac{i_n}{l_n - i_n} + \frac{l_n - k_n}{k_n}\right] = -\frac{R_n}{l_n}\left[(l_n - g_{ln})\frac{\Delta_{n(n-1)}}{\Delta_{nn}} + g_{ln}\right]$$

$$M_n \beta_n \frac{s_n l_n}{k_n (l_n - i_n)} = -\frac{R_n}{l_n}\frac{g_{ln} - i_n}{l_n - i_n} l_n$$

$$\therefore \quad M_n = -\frac{1}{\beta_n}\frac{k_n}{s_n} R_n \cdot \frac{g_{ln} - i_n}{l_n}$$

Fig. 1.—Solution of Equations of Theorem of Three Moments for Load on Span l_n by Determinants.

the distance of the right-hand fixed point from the right-hand support; s is the distance between the fixed points ($i + s + k = l$); R is the area of the bending-moment diagram due to the load on a freely-supported beam

$$\left(R = \int_0^l \frac{M_x dx}{EI_x}\right);$$

g_l and g_r are the distances to the centre of gravity of R from the left and right supports respectively; $\beta = \int_0^L \frac{x(l-x)dx}{EI_x l^2}$; and $\alpha = \int_0^L \frac{(l-x)^2\,dx}{EI_x l^2}$; for prismatic beams $\alpha = \frac{L}{3EI}$ and $\beta = \frac{L}{6EI}$.

Having calculated M_l and M_r, the bending moments on the unloaded spans can be calculated from the carry-over factors. The procedure is repeated for each loaded span separately and the bending moments are added together for each support. For prismatic beams the moments due to commonly occurring arrangements of loads can be calculated and recorded, thus reducing the time required for subsequent calculations. Some such bending moments are given in *Table* II.

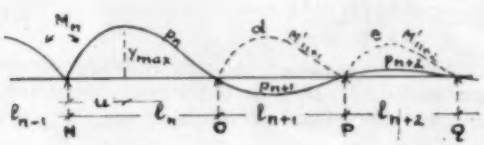


Fig. 2.

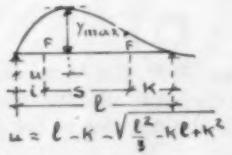


Fig. 3.

Influence Lines.

The first formula of *Table* II is of special interest because it is the equation of the influence line for the moments at the supports of a loaded beam. The bending moment at support N of the continuous beam shown in *Fig.* 2 is, for a unit concentrated load at a distance (a) from the left-hand support,

$$M_n = -\frac{a(l_n - a)}{l_n^2}\frac{i}{s_n}(2l_n - a - 3k_n) \quad . \quad . \quad . \quad (2)$$

As for a prismatic beam i and k cannot exceed $\frac{l}{3}$, the part P_n of the influence line for M_n due to a load on beam NO is completely negative. If the load is moved to beam OP, that is span l_{n+1}, the influence line for M_{n+1} is obtained in the same way (as shown dotted at d), and this moment also is negative. When, however, the load is on span l_{n+1} the moment at support N is

$$M_n = -c_{ln} \times M_{n+1},$$

where c_{ln} is the carry-over factor to the left in span l_n. Consequently the part P_{n+1} of the influence line for M_n is based upon the same equation as that for M_{n+1}, but the bending moment is positive (as M_{n+1} is itself negative) and the ordinates are those for M_{n+1} multiplied by the carry-over factor c_{ln}. In the

same way part P_{n+2} of the influence line for M_n is obtained from the ordinates for M_{n+2} multiplied by the product of the carry-over factors to the left in spans l_{n+1} and l_n [that is multiplied by $(c_{l(n+1)} \times c_{ln})$]; this it is seen will give negative values.

If equation (2) is differentiated with respect to (a) and the result equated to zero the distance (u) is obtained which gives the position of the load at which M_n is maximum (*Fig.* 3). That is

$$u = L - k - \sqrt{\frac{l^2}{3} - kl + k^2} \quad . \quad . \quad . \quad . \quad (3)$$

Substituting this value of u in equation (2) the maximum moment is obtained. In the case of two equal loads on one span the value of u refers to the resultant of these loads.

Examples.

EXAMPLE No. 1.—In *Table* III is shown a continuous prismatic beam ABCDE on five rigid and level supports. It is assumed that there is 75 per cent. fixity at A. The imposed loads are given at the bottom of *Table* III. The procedure for calculating the bending moments is as follows.

(1) Calculate the physical properties of the beams (*Table* III): (a) Calculate

TABLE III.

CARRYOVER FACTORS (see Table II 3).

$c_{l1} = \frac{1}{2} \times$ fixing degree $= \frac{0.75}{2} = 0.375$

$c_{l2} = \frac{\frac{1}{2} \times 12}{12 + 13.3 - \frac{1}{2} \times 13.3 \times 0.375} = 0.263$

$c_{l3} = \frac{\frac{1}{2} \times 7.5}{7.5 + 12 - \frac{1}{2} \times 12 \times 0.263} = 0.209$

$c_{l4} = \frac{\frac{1}{2} \times 7.5}{7.5 + 7.5 - \frac{1}{2} \times 7.5 \times 0.209} = 0.263$

$c_{r4} = \frac{\frac{1}{2} \times 7.5}{7.5 + \infty} = 0.-$

$c_{r3} = \frac{\frac{1}{2} \times 7.5}{7.5 + 7.5 - 0} = 0.250$

$c_{r2} = \frac{\frac{1}{2} \times 12}{12 + 7.5 - \frac{1}{2} \times 7.5 \times 0.25} = 0.324$

$c_{r1} = \frac{\frac{1}{2} \times 13.3}{13.3 + 12 - \frac{1}{2} \times 12 \times 0.324} = 0.285$

FIXED POINT DISTANCES.

$i_1 = \frac{0.375}{1 + 0.375} 20' = 5.46'$ $\quad K_4 = \infty = 0.-$

$i_2 = \frac{0.263}{1 + 0.263} 12' = 2.50'$ $\quad K_3 = \frac{0.250}{1 + 0.250} 7.5' = 1.50'$

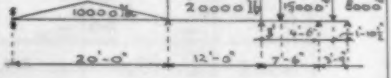
$i_3 = \frac{0.209}{1 + 0.209} 7.5' = 1.30'$ $\quad K_2 = \frac{0.324}{1 + 0.324} 12' = 2.93'$

$i_4 = \frac{0.263}{1 + 0.263} 3.75' = 0.78'$ $\quad K_1 = \frac{0.285}{1 + 0.285} 20' = 4.43'$

SUMMARY

	A	B	C	D	E
l =		20'-0"	12'-0"	7'-6"	3'-9"
I =		6000 in^4	4000	4000	2000
$\frac{l}{I}$ =		133 (ratio)	12	7.5	7.5
c_l =		0.375	0.263	0.209	0.263
c_r =		0.285	0.324	0.250	0.-
i =		5.46	2.50	1.30	0.78
S =		10.11	6.57	4.70	2.47
K =		4.43	2.93	1.50	0 -
l =		20.-	12.-	7.50	3.75

Load on beam



carry-over factors c_l and c_r. (b) Calculate the fixed-point distances i and k. (c) Prepare a summary.

(2) Calculation of support moments (*Table* IV) : (d) From *Table* II (equations 16, 13, 1, and 8) calculate the support moments for both ends of each beam due to the loads on each span separately. (e) Tabulate the moments thus calculated. (f) Carry over moments to the unloaded spans for each case. (g) Add the moments thus obtained for each support.

EXAMPLE No. 2.—The influence line for a support moment, say M_c of the beam of Example 1, is the elastic line of the beam if the beam is assumed to be cut at support C and the internal (equal and opposite) moments at C are replaced by similar external moments. The elastic line can be plotted by drawing first an initial funicular (*Fig.* 4) according to the method due to Professor Vreedenburgh, that is an ordinate of any length BB′ is drawn vertically from

TABLE IV.

Load on		ft.lb.
A - B	$M_A = -\frac{5}{16}\frac{5.46}{10.11}(20-2\times4.43)\,10{,}000$	$= -$ 18,800
	$M_B = -\frac{5}{16}\frac{4.43}{10.11}(20-2\times5.46)\,10{,}000$	$= -$ 12,430
B - C	$M_B = -\frac{1}{4}\frac{2.50}{6.57}(12-2\times2.93)\,20{,}000$	$= -$ 11,700
	$M_C = -\frac{1}{4}\frac{2.93}{6.57}(12-2\times2.50)\,20{,}000$	$= -$ 15,600
C - D	$M_C = -\frac{3\times4.5}{7.5^2}\frac{1.30}{4.70}(15-3-3\times1.50)\,15000$	$= -$ 7,470
	$M_D = -\frac{3\times4.5}{7.5^2}\frac{1.50}{4.70}(15-4.5-3\times1.30)\,15{,}000$	$= -$ 7,560
D - E	$M_D = -\frac{3}{8}\frac{0.78}{2.97}(3.75-0\quad)\,8{,}000$	$= -$ 2,950

SUMMARY

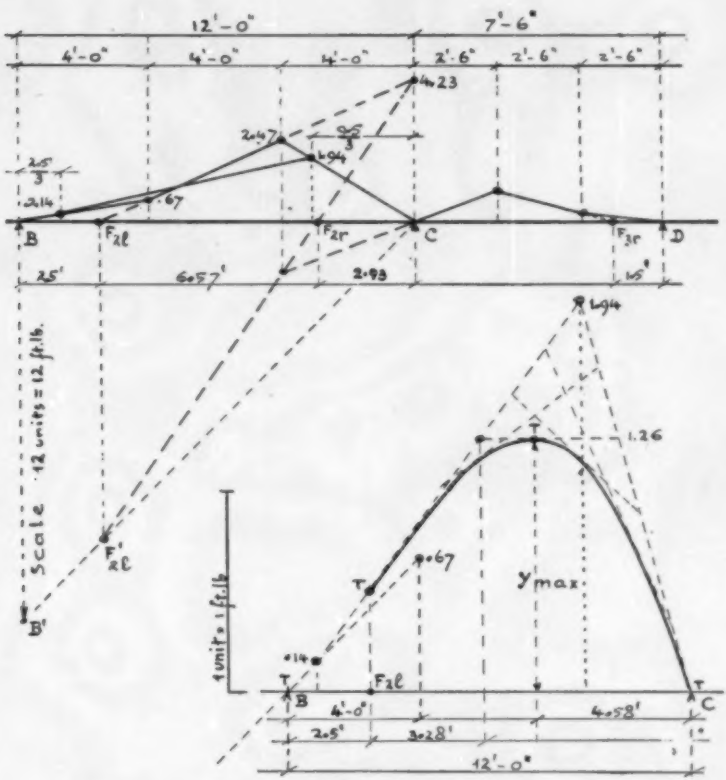
Load on span	M_A	M_B	M_C	M_D
A - B	− 18,800	− 12,430	+ 4030	− 1010
B - C	+ 4,380	− 11,700	− 15,600	+ 3900
C - D	− 740	+ 1970	− 7470	− 7560
D - E	+ 60	− 160	+ 620	− 2950
Total	− 15,100	− 23,320	− 18,420	− 7620

B to fix the scale of the bending-moment ordinates, because for the purpose of drawing the funicular the scale of BB′ is the product of a unit load and a length BC. The initial funicular can then be started by drawing the first link between the fixed points F'_{2l} and F_{2r}, after which the whole funicular is known. Secondary links can be added to facilitate drawing the real elastic line as a fair curve. This has been done in *Fig.* 5, for span BC only. The main secondary link is the horizontal link for the maximum ordinate Y_{max} which is at a distance (u) from (c) (equation 3), such that

$$u = 12 - 2{\cdot}50 - \sqrt{\frac{144}{3} - 2{\cdot}50 \times 12 + 2{\cdot}5^2} = 4{\cdot}58 \text{ ft.}$$

The maximum ordinate can be checked from formula 1 of *Table* II:

$$M_{max} = -\frac{4{\cdot}58 \times 7{\cdot}42}{12^2}\frac{2{\cdot}93}{6{\cdot}57}(12 + 7{\cdot}42 - 3 \times 2{\cdot}50) = -1{\cdot}26 \text{ ft.-lb.}$$



Figs. 4 and 5.

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Precast Footbridge of 230-ft. Span.

THE prestressed footbridge shown in *Fig.* 1 was recently built across the lake behind the Vagli di Sotto barrage in Toscana, Italy. Because of the great height above ground level, the poor subsoil, and objections to scaffolding in the lake, the three-pinned arch, of about 230 ft. span and with a rise of 75 ft., was precast in halves. Each part was placed in its bearing (formed of short lengths of steel pipe filled with reinforced concrete) and hoisted from the ground, through the vertical, to its position in the bridge (*Fig.* 2). The forces exerted on the members and the stresses in the cables at the different phases were calculated, and the cables adjusted as necessary during the erection of the arch. [This note is abstracted from " Schweizerische Bauzeitung " for November 20, 1954.]

Fig. 1.

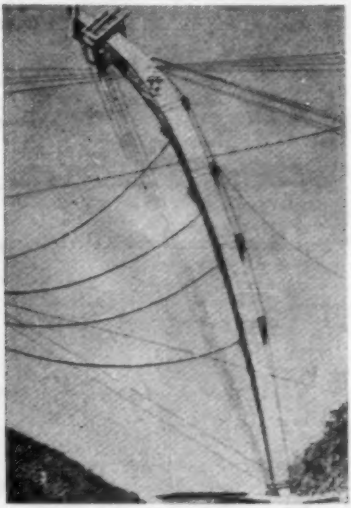

Fig. 2.

Lectures on Roads.

COURSES of lectures on road materials and construction will be held at the Road Research Laboratory, Harmondsworth, during the autumn and winter of 1956–7. The lectures will deal with the fundamental properties of road materials, and will include results of recent research and their application. The courses will be on Soil mechanics, Tar and bituminous materials, Concrete, and Traffic and safety. Fees for the courses vary from £10 10*s.* to £7 7*s.* Further information may be had from the Director, Road Research Laboratory, Harmondsworth, Middlesex.

Foundations to Resist Subsidence.

THE North Staffordshire Technical College at Stoke-on-Trent is to be greatly enlarged to include several new colleges in addition to the extension of the existing engineering department. The College of Ceramics, which forms in volume about one-tenth of the whole scheme, is the first of the new colleges to be completed, and comprises a teaching building and a workshop building. Owing to possible future mining of coal seams at from shallow to moderate depths under the site, both buildings are designed to have high resistance to the effects of subsidence.

The teaching building is six stories high and 91 ft. by 60 ft. on plan. There is nothing unusual in the superstructure, which is a reinforced concrete frame with spandrel walls and solid concrete floors. The external columns are exposed in fair-faced concrete. The suspended floors incorporate heating coils, and have slip-tiles throughout the soffit. The foundation (*Fig.* 1) is a grid of prestressed concrete beams carried on large bearing pads approximating to three-point supports to reduce the effects of hogging or sagging of the ground, which may occur in any direction, including diagonally. The exterior longitudinal beams and those along the corridor walls are in reinforced concrete. A 1 : 2 : 4 mixture, consolidated by vibration, was used for the reinforced concrete.

The two main beams (A in *Fig.* 1) are 91 ft. 2 in. long, 2 ft. wide and 6 ft. 6 in. deep, and have top flanges 6 ft. 8 in. wide by 1 ft. thick for part of their length and a bottom flange 4 ft. wide by 1 ft. 6 in. deep for the full length. Thirty-five 1¼-in.

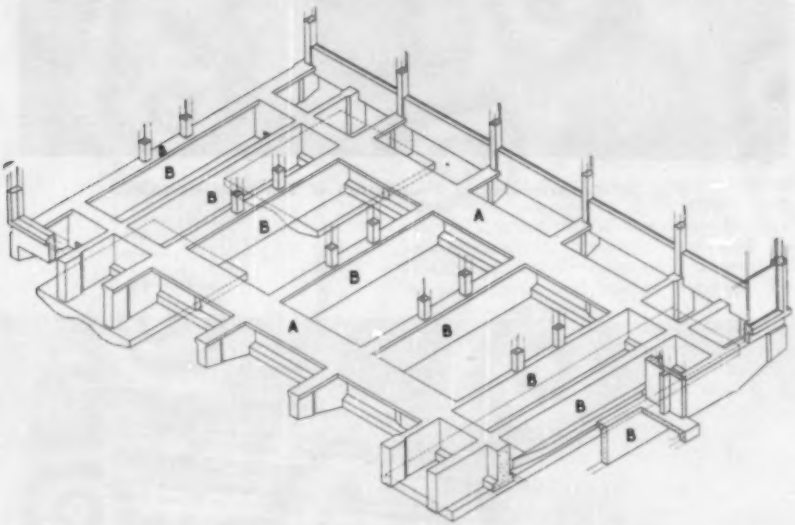

Fig. 1.—Arrangement of Foundation.

diameter Macalloy high-tensile bars (*Fig.* 4), each tensioned to 42 tons per square inch, were used, producing a total prestressing force of 1420 tons in each beam. The beams (B) are also 6 ft. 6 in. deep, varying in thickness from 1 ft. 2 in. to 1 ft. 8 in., and are prestressed with 12, 14, or 15 similar bars according to the load to be resisted. The bars were fixed in flexible sheaths before the concrete was placed. After the bars were tensioned, the cavities between them and the sheaths were filled under pressure with neat high-alumina cement grout with a water-cement ratio of 0·5.

The materials for the prestressed

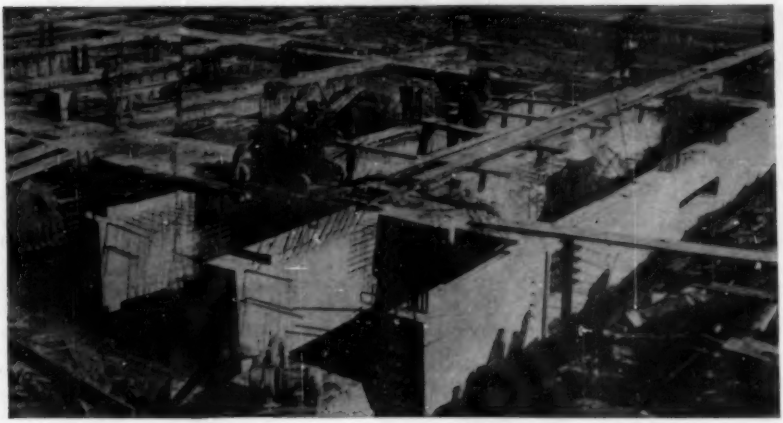

Fig. 2.—Construction of Foundation of Teaching Building.

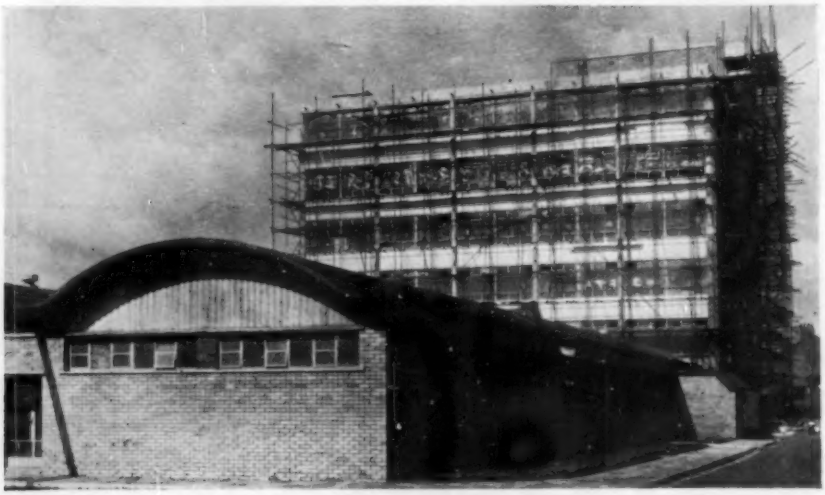

Fig. 3.—Teaching Building at Rear. Part of Workshop in Foreground.

Fig. 4.—Half Longitudinal Section and Cross Section of Beam.

concrete were measured by weight and comprised 112 lb. of cement, 200 lb. of sand, 152 lb. of $\frac{3}{8}$-in. to $\frac{1}{16}$-in. aggregate, and 240 lb. of $\frac{3}{4}$-in. to $\frac{3}{8}$-in. aggregate. The water-cement ratio was 0·4, and the concrete, which was required to have a cube strength of 6000 lb. per square inch at twenty-eight days, was consolidated by immersion vibrators.

The workshop building, which covers an area of 170 ft. by 166 ft., was too large to be dealt with by this method of three-point support. Instead, it is divided into fifteen single-story structures separated by corridors. Thirteen of these structures have single-span shell roofs carried on four columns and two have twin shells carried on six columns. The corridors between the buildings have flat roofs carried by tubular steel columns; at the ends of the shells the roofs of the corridors are cantilevered off them. Because shell roofs are to some extent flexible and able safely to withstand considerable torsional distortion,* no special foundations were needed; some provision against hogging or sagging is, however, provided by reinforced concrete beams under the eaves valleys and gables between the main bearing pads.

Figs. 2 and 3 show the work in progress.

The total cost of the work described was estimated at £204,000. The City Architect of Stoke-on-Trent, Mr. J. R. Piggott, F.R.I.B.A., is responsible for the new colleges, and Mr. R. Pemberton and Mr. J. T. Stephens were successively assistant architects in charge of the work. Mr. Donovan H. Lee, M.I.C.E., is the consulting engineer, Messrs. Reynolds & Young the quantity surveyors, and Messrs. Hoare, Lea & Partners the heating, ventilating and electrical consultants. The main contractors, who also carried out the prestressed and reinforced concrete work, are Messrs. C. Cornes & Son, of Hanley.

* New Technical College, Kingston-upon-Hull, by J. J. Lewkowicz; Conference on the Correlation of Calculated and Observed Stresses. Inst. Civ. Engrs., 1955, Paper No. 17, Group III, page 290. Also "Indian Concrete Journal," July, 1954, The Effect on a Shell Roof of the Settlement of Supports.

Book Reviews.

"Design and Construction of Engineering Foundations." By F. D. C. Henry. (London: E. & F. N. Spon, Ltd. Price 63s.)

THE author is a lecturer at the University of Leeds and the book is notable for its many references to books, reports, and papers on the subject and to structures in many parts of the world. It is a good source of reference for the practising engineer, and should also be useful to young men leaving college. The work is mainly descriptive of methods of construction, and where it is mathematical, as in the case of raft foundations, numerical examples are given. Among the subjects dealt with are scour in river beds where the flow of water is affected by bridge piers; soil mechanics; actual and predicted settlements of structures founded on clay, etc.; British and American codes of practice for reinforced concrete; bearing areas and settlements; steel grillages; reinforced concrete footings; continuous footings and rafts, with some criticism of the semi-empirical methods of assessing the stresses in rafts that have been commonly used for the past half-century; retaining walls, with a comment on "the crude approximations which have been employed in designs", and a plea for full-scale tests, particularly on sheet-piled walls; culverts; cofferdams and caissons; piling, with a warning culled from American sources on the uses of dynamic load-resisting formulæ; mining subsidence; underpinning; the uses of divers and "frogmen" in under-water work; and bridge piers, with some data on the hydraulic forces on piers inclusive of wave action.

"Cemento Armato Precompresso." By Carlo Cestelli Guidi. (Milan: Ulrico Hoepli. 1956. Price 3500 lire.)

THE third edition of this book (in the Italian language) has been brought up to date; it is an excellent book from which little has been omitted that might be required in the design of any prestressed concrete structure. The arrangement and contents follow the lines now general in books on the subject, starting with descriptions of the systems available followed by chapters on the design and analysis of freely-supported members, a short treatment of statically-indeterminate structures, and ending with descriptions of structures in Italy and elsewhere. There is an interesting chapter on composite members of prestressed and unprestressed concrete. The part dealing with continuous structures is confined to continuous beams and single-story frames: it includes an example of a frame at a factory in Rome of which the span is about 160 ft., the beam only being prestressed while the columns are of reinforced concrete. Some of the extremely interesting Italian structures, although well illustrated, deserve more detailed descriptions. An appendix gives the Italian regulations for prestressed concrete.

"Zehnteilige Einflusslinien für Durchlaufende Träger." Vol. III. By Georg Anger. (Berlin: Wilhelm Ernst & Son. Price 27 D.M.)

THIS work is a development of Griot and Winkler's tables of bending moments for continuous beams. There are tables of influence lines (ten divisions per span) for beams continuous with from two to five spans and with many ratios of lengths of spans. Maximum and minimum bending moments and reactions are given for uniformly-distributed loads. For other types of load where it is not considered necessary to use influence lines, the load factors in Clapeyron's equation are given in tabular form, with diagrams. The conception of the support moment is fully explained. The use of the tables of influence lines for beams with different moments of inertia is explained and illustrated by a numerical example.

To the already large number of ratios of lengths of span the following have been added in this edition: 1 : 0·5 : 1, 1 : 1·28 : 1, 1 : 1·35 : 1, and 1 : 0·5 : 0·5 : 1. Tables are also given showing the influence of the bending moment of a cantilever on the bending moments and reactions of continuous beams of two, three, and four spans.

"Das Arbeitsverhalten des Rüttelverdichters auf plastisch-elastischem Untergrund." By Uwe Bathelt. (Berlin: Wilhelm Ernst & Son. Price 8.40 D.M.)

THIS is a report of an investigation of the mechanics of vibrators used for the compaction of plastic-elastic soils. It is limited due to its highly specialised nature. It is stated that measurements made on sites agreed in general with the theory of the formation of waves in soil due to vibration.

Precast Concrete in Russia.

In the U.S.S.R. several precast concrete factories have been built with very large capacities and with a high degree of mechanisation for the production of concrete members for blocks of residential flats. About 20,000 of these blocks of flats are to be built during the current five-years' plan and the structures are standardised so as to permit economical production of the members.

Method of Prestressing.

In the production of prestressed beams, a trolley, the oiled platform of which forms the base of the mould, carries formers on which high-tensile wire of about one-tenth inch diameter is wound. The machine (*Fig.* 1) positions the wire at 1-in. centres on the first former and at the same time tensions it to 70 tons per square inch. A second former is then lowered into place and the positioning and tensioning are continued, and so on with more formers until the required number of wires (maximum 24) has been placed and tensioned. The machine then stops automatically and the end of the wire is anchored and cut off. All the operations are controlled from a panel, and it is said to take 5½ minutes to place and tension the wires for two beams cast on their sides.

The trolley with the tensioned wire in place is passed forward, metal sides are fixed to the base (*Fig.* 2), and supplementary reinforcement links and lifting hooks are added. It is then passed to a vibrating platform over which a concrete-placing device passes and places the concrete for two beams through hoppers (*Fig.* 3). In the next position the upper surface of the beam is smoothed. All the processes are controlled from an elevated cabin and no men are employed on the floor of the shop.

Reinforced Products.

At the same factory in Moscow, which has a capacity of 160,000 cu. yd. of precast concrete a year, there are four production lines for making hollow roof slabs, hollow floor slabs, columns, solid slabs, and wall slabs with openings for doors and windows.

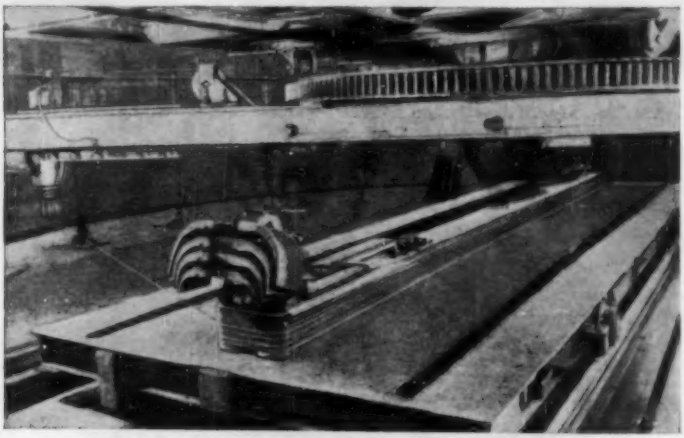

Fig. 1.—Method of Tensioning Prestressing Wires.

The reinforcement for slabs is assembled and welded by a machine that is electrically operated from a control cabin and is stated to make 25,000 welds per hour in the production of a mesh of ¼-in. longitudinal bars and ⅛-in. transverse wires.

In the production of two-story wall-panels (*Fig.* 4) faced on the front with ceramic tiles and on the back (the inside of the building) with insulating cellular concrete, the first step is to lay a ribbed rubber mat (*Fig.* 5) on the bottom of the

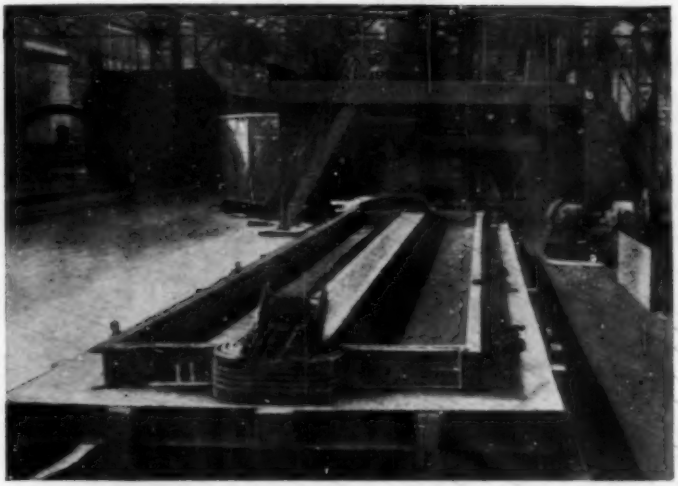

Fig. 2.—Mould Ready for Placing Reinforcement and Concrete.

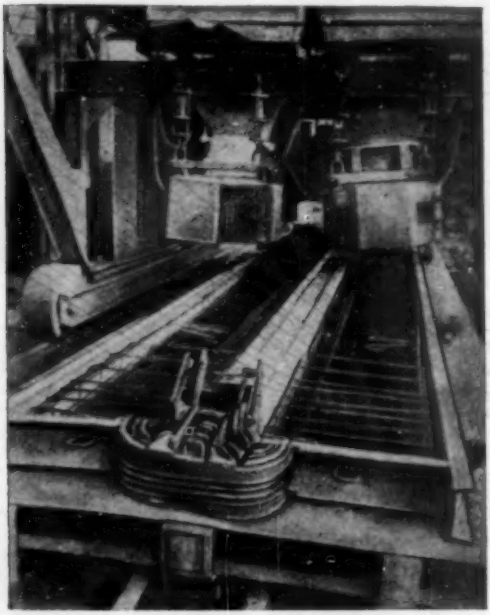

Fig. 3.—Placing Concrete for Prestressed Beams.

mould. (The tiles were at first laid directly on the base of the mould, but they became displaced when the concrete was vibrated and cement grout leaked between the tiles and spoiled the surface. The use of rubber mats prevents this.) Thin ceramic tiles are then laid face downwards between the ribs on the mat—this is one of the few manual operations in the plant. The mesh reinforcement is then lowered into the mould by a crane and placed in position.

When the reinforcement is placed in a mould a button is pressed in the control cabin, and the mould moves along the line to a position where round steel cores are pushed through holes in the ends of the mould. The mould then passes on to a vibrating table, and a layer of concrete is spread evenly over the bottom by a travelling hopper which discharges concrete over the full width of the mould while it is being vibrated. The hopper passes over the mould, filling it in layers until the required thickness is placed, and then returns to the end of the line where it is kept charged with concrete from the belt conveyor. After vibration, pressure of another button causes the metal cores to be pulled through and clear of the moulds, and pressure of another button causes the mould to move along to another position where a vacuum mat is lowered on to the surface to remove excess water.

When the mould reaches the next position a hopper is passed over it to apply a thermal insulation of cellular concrete to the upper surface (the inside of the wall); this is smoothed so that subsequent plastering is unnecessary. Pressure on another button causes the moulds to travel towards the curing tunnels, where they are automatically lifted off the rollers and passed on to a conveyor in the tunnel. As a fresh slab enters the tunnel, a cured slab is lifted out at the other end. The rate of production is such that sixteen slabs leave the tunnel every hour. Up to

Fig. 4.—Erecting Wall Slabs.

Fig. 5.—Rubber Mat used for Positioning Face Tiles.

this stage only the men who arrange the reinforcement and the tiles are employed on the floor of the factory. All the other processes are controlled by an operator in an elevated cabin, who is automatically warned by a green light as each process is completed.

The reinforcement for beams and columns is assembled and welded automatically from a control panel. By moving different controls, the main bars are lifted by a magnet suspended from an overhead runway and taken to a position where they are cut to length and cleaned. The ends are then placed in grooves in a revolving drum, and automatically moved along to a position where the transverse bars are welded to the main bars. Eight cages, with about 2000 welds, are made per hour.

Method of Erection.

In the erection of multiple-story buildings the first operation is the placing, bedding in mortar, levelling and alignment of precast foundation blocks about 6 ft. or 8 ft. square by 2 ft. or 3 ft. thick with a square opening in the centre to receive the basement columns. The columns fit loosely into these sockets and are aligned by means of wedges placed between the column and the side of the socket, and grouted later. The basement columns and walls are erected first and the ground floor, consisting of hollow precast slabs, is laid. When the floor is completed a steel template provided with clamps to hold the columns in position is lowered on to it by a tower crane. The columns are erected, the clamps tightened, and the main and secondary beams placed in position. One column is then fixed correctly and, by means of the template, all the other columns and beams are automatically aligned. All the precast members have projecting steel plates or angles fixed to the reinforcement, and before the erection template is removed they are welded

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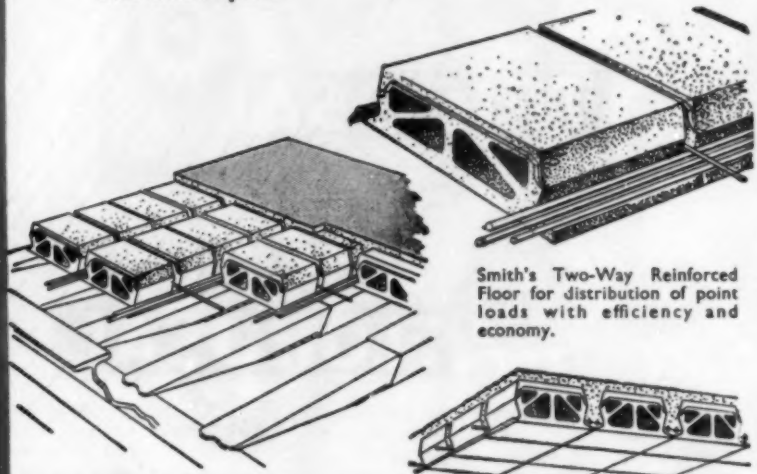

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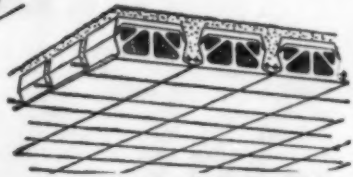

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together. The clamps are then removed and the template moved to another building.

When the frame of one story is completed the floor slabs are lowered into place and the operation is repeated for the next story. Communication between the man directing the positioning of the members and the crane driver is by walkie-talkie telephone, so that there is no need for the crane driver to be able to see the position into which he (or she) is lowering a member.

Fig. 4 illustrates the method of erecting the walls. Two-story panels are first placed in position and single-story panels with window openings are lowered between them. The tower cranes used have a capacity of 5 tons, they are tall enough to place the roof slabs in buildings of fourteen stories, and they are operated by women as well as men.

The foregoing is based on a film brought to this country by a Russian delegation and shown in London under the auspices of the Reinforced Concrete Association.

A New Type of Floor.

A NEW type of floor requiring no shuttering or props and all the parts of which can be lifted by hand, comprises partly precast and partly in-situ concrete inverted tee-beams between which span lightweight hollow concrete blocks. A precast slab 6 in. wide and 2 in. deep forms the soffit of the beam and contains four $\frac{1}{2}$-in. diameter longitudinal bars (*Fig.* 1). Stirrups protrude from the top of this slab and support an upper $\frac{3}{8}$-in. diameter longitudinal bar. A continuous $\frac{3}{8}$-in. diameter bar is welded to the top and bottom bars to form diagonal reinforcement to resist shearing forces.

The hollow blocks are made with foamed-slag aggregate. They have two cavities, and the sides are rebated to fit on the precast parts of the beams. Along the centre of the top of the blocks and extending the full length is a groove 3 in. wide by 1 in. deep in which electrical conduit may be placed. The blocks are 6 in., 7 in., or 8 in. deep by 1 ft. 8 in. long by 1 ft. 6 in. or 1 ft. 10 in. wide. A stronger floor may be made by placing two or more beams side by side between the blocks. When the beams and blocks have been laid the cavities between are filled with concrete.

Tests have been made at the Building Research Station on floors 6 in. thick with spans of 7 ft. 9 in., 11 ft. 9 in., and 16 ft. 3 in.; the compressive strength of the in-situ concrete at the time of the test was 2770 lb., 2850 lb., and 2620 lb. per square inch respectively. The floors failed when subjected to the equivalent of uniformly-distributed loads of 1310 lb., 620 lb., and 330 lb. per square foot respectively.

It is stated that floor thicknesses of 6 in. are suitable for a span of 16 ft., 7 in. for 18 ft., and 8 in. for 20 ft. The system, which is patented, has been developed by Messrs. William Sindall, Ltd., of Cambridge.

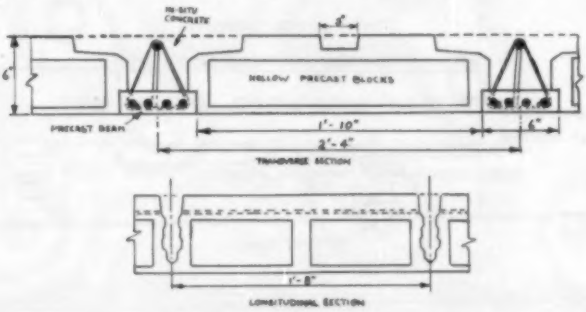

Fig. 1.

A Tower Liable to Subsidence.

A FIRE-STATION recently built at Burslem for the Stoke-on-Trent Corporation comprises single-story structures and a hose-tower 65 ft. high. Because the site is liable to subsidence due to mining, the single-story buildings are on raft foundations, and in the case of the tower (*Fig.* 1), which is a reinforced concrete frame with brick walls, provision is made for jacking the structure at any of the corners in the event of settlement.

Plans and sections of the base of the tower and the foundation are given on p. 501, and *Fig.* 2 shows the arrangement of the jacks and the method of raising a corner. The jacks would be placed in the spaces left for them, and would rest on a bearing-plate. At the top there would be two plates, the upper one having a rounded projection pivoting in a recessed lower one, to enable the lifting force to be applied normally to the underside of the plinth of the tower. When the tower had been lifted to its required alignment, the gap between the foundation and the plinth would be tightly packed with a stiff mixture of cement-sand mortar, and the jacks left in position until the packing was strong enough to carry the weight of the tower. The jacks would be of the hydraulic type, so that synchronisation of their operation could be closely controlled.

The architect is Mr. J. R. Piggott, T.D., City Architect of Stoke-on-Trent, and the

Fig. 1.—Tower at a Fire Station.

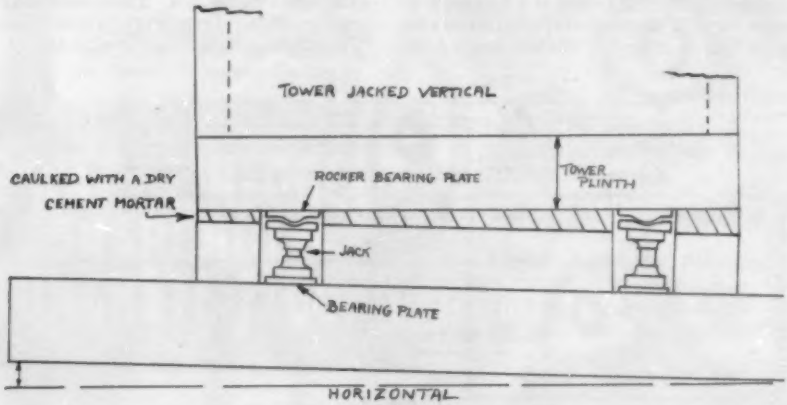

Fig. 2.—Arrangement for Jacking.

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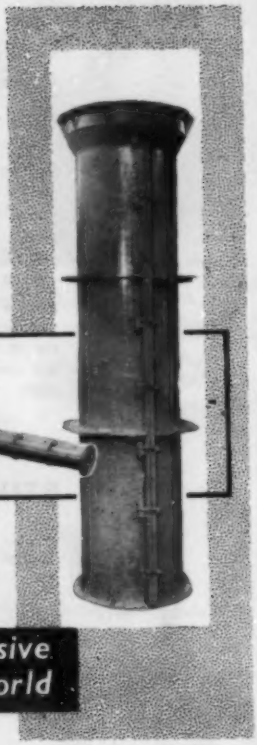

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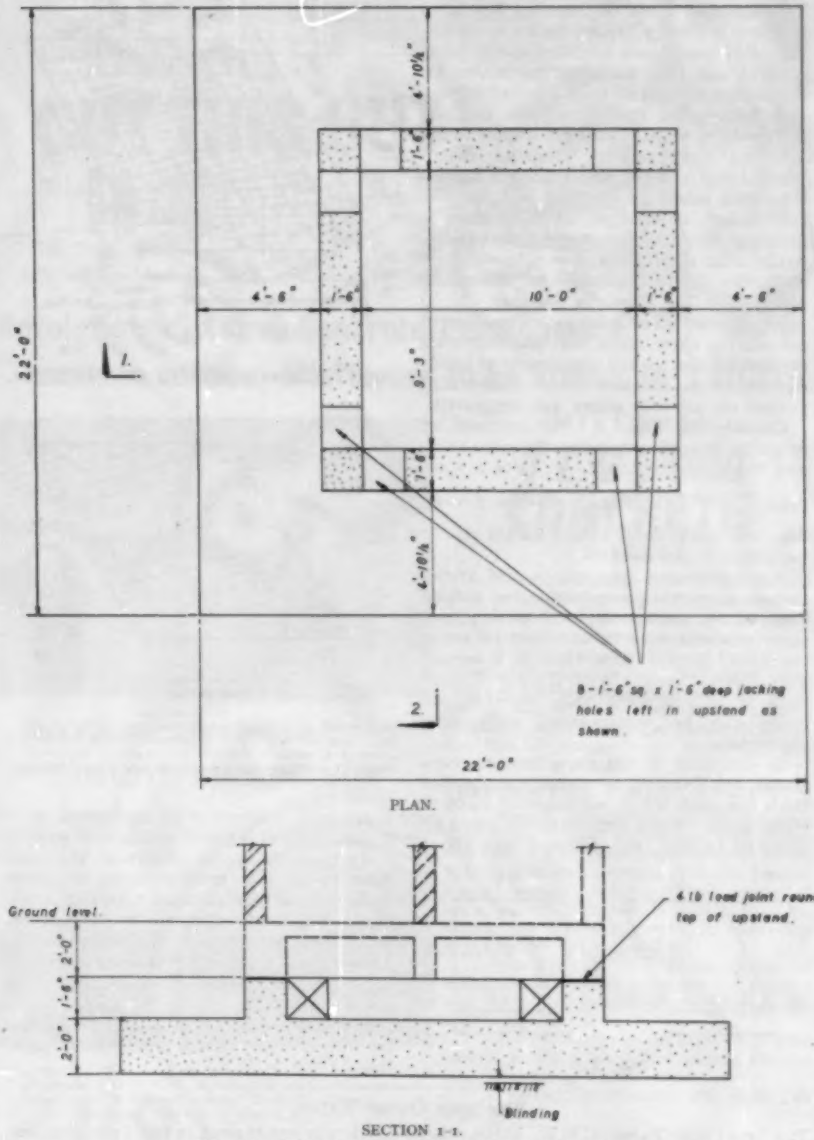
contractors Messrs. Naylor & Nutt. The British Reinforced Concrete Engineering Co., Ltd., designed the reinforced concrete and supplied the reinforcement.



PLAN.

SECTION 1-1.

Fig. 3.—Plan and Section of Foundation.

(*See page* 500.)

Design of Bridge Decks.

THE German Code of Practice No. 1075 requires slabs for bridge decks to be designed in accordance with the elastic-plate theory, and this book* gives tables for the design of such slabs. The tables provide factors for calculating the bending moments in slabs of different span ratios and end conditions for uniformly-distributed loads and for combinations of concentrated loads as specified in Code No. 1072. The application of the tables is demonstrated by numerical examples. Apart from a revision of a note on skew slabs, this third edition does not materially differ from the previous editions.

At present there is no exact method of calculating skew slabs, but the following empirical rules for the assessment of bending moments in skew slabs freely supported on all four edges are suggested.

Considering *Fig.* 1, the increase of moment M_x depends upon the span ratio and the angle of the skew. For a span ratio $\frac{l_y}{l_x} = 1$ and an angle of skew $\beta = 60$ deg., the increase for a skew slab is said to be about 5 per cent.

For decreasing span ratios and angles the skew moment increases. For a span ratio of 0·3 and an angle of 30 deg., the skew moment may be assumed to be 20 per cent. greater than that of a square slab of equal area. With the aid of these data it is suggested that intermediate cases can be interpolated sufficiently accurately.

In direction Y the skew moment was found by Vogt to be somewhat smaller than the moment in rectangular slabs of equal area. For a span ratio of 1 and an angle of 60 deg., the decrease was about

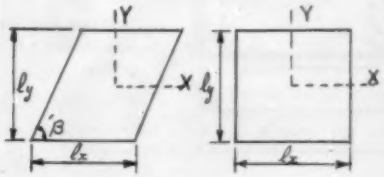


Fig. 1.

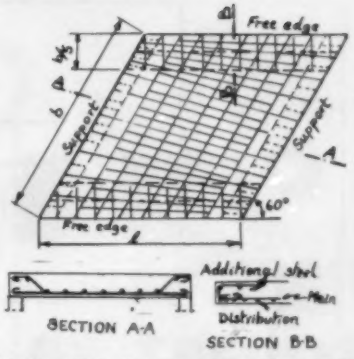


Fig. 2.—Slab Supported on Two Sides.

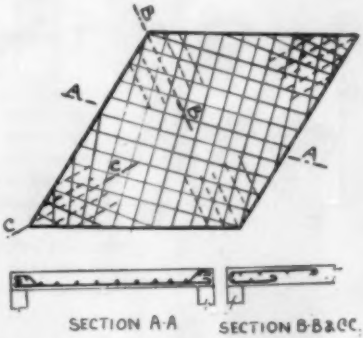


Fig. 3.—Slab Supported on Four Sides.

6 per cent. There is no difference with a span ratio of 0·3 and an angle of 30 deg.

Typical diagrams showing the disposition of the reinforcement of skew slabs with a span ratio of 1 and an angle of 60 deg. and with two or four edges supported are given (*Figs.* 2 and 3). They appear to incorporate features which are already accepted.

* "Fahrbahnplatten von Strassenbrücken Berechnungstafeln für Lasten nach Din 1072." By Hubert Rüsch (Berlin: Wilhelm Ernst & Son. Price 24 D.M.)

The late Oscar Faber.

THE late Oscar Faber, C.B.E., D.Sc., whose death was announced in our June number, left estate valued at £287,778 gross and £265,710 net. The estate duty paid was £185,336.

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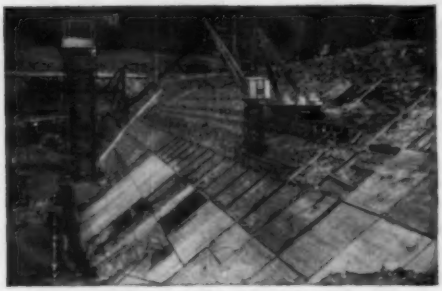

Photograph by permission of The North of Scotland Hydro-Electric Board. Contractor: Richard Costain Ltd. Consulting Engineers: Sir William Halcrow & Partners. Contract: Garry Hydro Scheme, Quoich Dam, Scotland. In situ cast facing slabs—surface processed.

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New Method of Ascertaining the Tensile Strength of Concrete.

THE idea of calculating the tensile strength of concrete by crushing cylinders in the direction of a diameter is believed to have been first proposed by Dr. Isuneo Akazava in Japan in 1943 and experiments were made in Brazil in 1953 by Sr. Carneiro. It is reported that it is proposed to use this method in Poland in place of the usual tensile test. The following account of the method is given by Professor Axel Efsen and Mr. Ole Glarbo in " Beton og Jernbeton " (the Journal of the Danish Institution of Civil Engineers), No. 1, 1956.

The cylinder is placed with its horizontal axis between the platens of the crushing machine, and narrow strips of wood or similar material are inserted as cushions along the upper and lower generatrices (*Fig.* 1). When pressure is applied, tensile stresses are produced in the vertical plane through the axis. These stresses are almost uniformly distributed throughout this plane, and are

$$\sigma_{sp} = \frac{2P}{\pi dh},$$

where σ_{sp} is the tensile stress (termed the " splitting " stress), d the diameter, h the length of the cylinder, and P the applied force. This formula is based on the theory of elasticity and has been established by various authorities. Based on experiments carried out by Akazava and Carneiro, it expresses the correlation between the compressive stress, σ_p, and the " splitting " stress by the formulæ

$$\sigma_{sp} = 0{\cdot}396.\ \sigma_p^{0{\cdot}73} \text{ (Akazava).}$$

$$\sigma_{sp} = 0{\cdot}335.\ \sigma_p^{0{\cdot}735} \text{ (Carneiro).}$$

The results of the Danish experiments may be combined into a similar formula, namely,

$$\sigma_{sp} = 0{\cdot}435.\ \sigma_p^{0{\cdot}73}.$$

Three series of tests have been carried out at the Building Research Laboratory of the Danish Technical University. Of the 238 cylinders tested, half were used for the ordinary cylinder compression test and half were tested transversely.

In the first series the effect of the dimensions of the cylinders was investigated. Three sizes of cylinder made with rapid-hardening Portland cement were tested, namely, 15 cm. diameter by 30 cm. long, 10 cm. diameter by 20 cm. long, and 10 cm. diameter by 10 cm. long. The average variations

$$\sqrt{\frac{(x - x_i)^2}{n - 1}}$$

in the compressive strength varied from 5·8 to 12·4 per cent. and in the tensile strength from 4·5 to 12·6 per cent. The dimensions of the cylinders had hardly

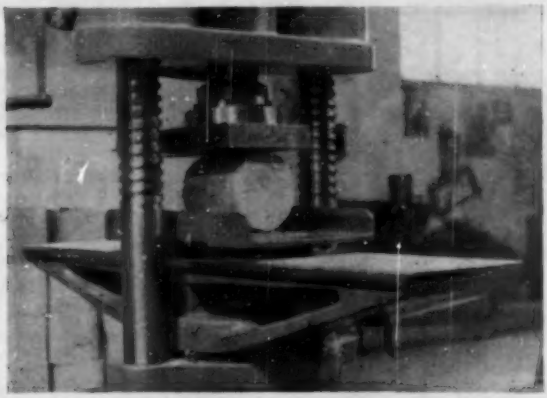


Fig. 1.—Transverse Tensile Test on Cylinders.

any effect on their compressive or splitting strength.

In the second series an endeavour was made to keep the compressive stress uniform at 200 kg. per square centimetre, and cylinders of 15 cm. diameter only were used. Specimens were made with ordinary Portland cement, rapid-hardening Portland cement and extra-rapid-hardening Portland cement and were cured under different conditions. The average variation in compressive strength of the different batches varied from 2·6 to 10·9 per cent. and of the tensile strength from 22·1 to 24·7 per cent. The "splitting" strength was found to be independent of the conditions of curing. The compressive strength of concrete made with rapid-hardening Portland cement was also independent of the curing conditions. With ordinary Portland cement slightly higher strength was generally obtained when using standard curing instead of curing in water, while concrete made with extra-rapid-hardening Portland cement had the opposite tendency.

In the third series of tests cylinders of 15 cm. diameter were used, but some specimens measuring 10 cm. square by 60 cm. long were made in order to determine the bending strength. In the bending tests the span was 54 cm. and the load was applied at the third-points. The specimen was placed so that the top as cast was in compression in bending. Rapid-hardening Portland cement was used and the specimens were cured under the same conditions but the water-cement ratio was varied. Some specimens were vibrated and some hand tamped. In these tests there was a tendency for the ratio of the tensile strength in bending to the "splitting" strength to fall with increase in strength. From the results of the tests the equation

$$\sigma_p = (5 + \tfrac{1}{8}\sigma_{sp}) \times \sigma_{sp}$$

was derived.

An investigation of Akazava's and Carneiro's results shows that nearly the same approach to these may be obtained by using the somewhat simpler formulæ

$$\sigma_p = (6 + \tfrac{1}{8}\sigma_{sp}) \times \sigma_{sp} \text{ (Akazava).}$$

$$\sigma_p = (8 + \tfrac{1}{8}\sigma_{sp}) \times \sigma_{sp} \text{ (Carneiro).}$$

It appears that the main difference between the results was due to the aggregates used.

A Novel Buttress for an Arch Roof.

In the construction of a roof over a market at Audubon, N.J., U.S.A., with an unobstructed floor area of 113 ft. 6 in. by 154 ft. 6 in., two-hinged laminated-timber arch ribs are supported by reinforced concrete rigid frames with horizontal top and bottom members and a vertical member that acts as a column for a low exterior wall. The buttresses transmit the horizontal thrust to a tie below the floor slab. The vertical loads are carried by tubular metal columns between the top and bottom members of the frame, forming a low arcade along the sides of the main area (*Fig.* 1).

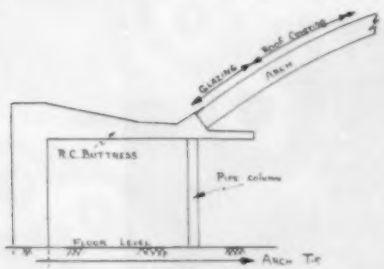
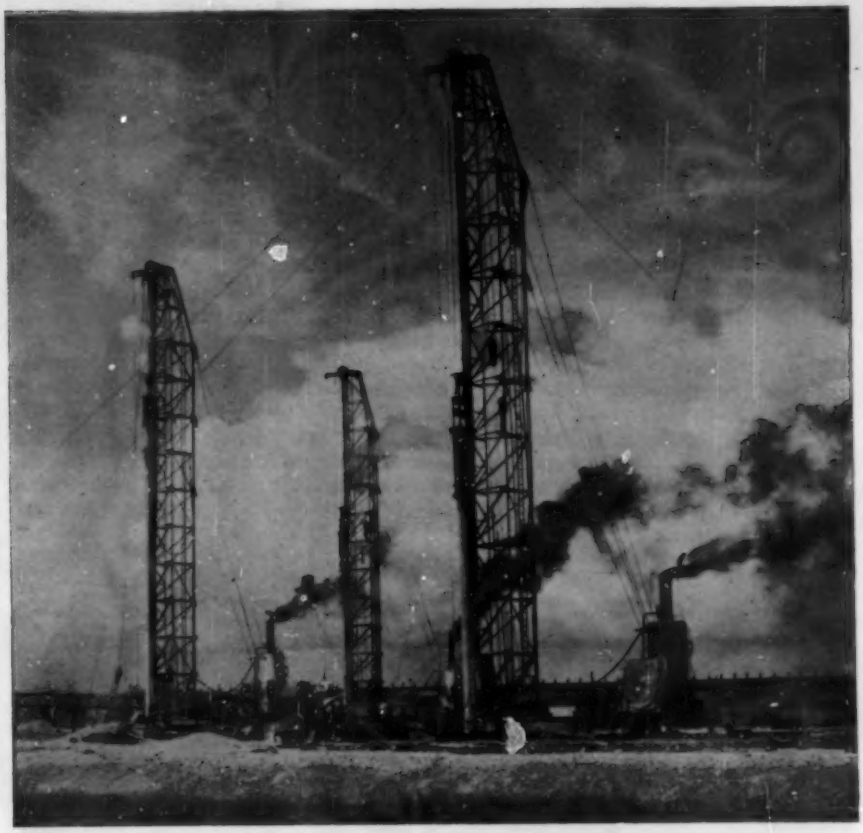


Fig. 1.—General Arrangement.

The consulting engineers are Messrs. Victor Gruen Associates, and the contractors the McClain Construction Co., of Philadelphia. The foregoing is abstracted from "Engineering News-Record" for December 8, 1955.



The VIBRO process is based on correct engineering principles and ensures the formation of piles of the precise length and size to suit the specified working loads.

The three Vibro plants shown above are forming 17" diameter piles varying from 60 to 70 feet in length, designed to carry working loads of 60 tons each.

BSP

VIBRO

CAST-IN-PLACE REINFORCED CONCRETE PILES

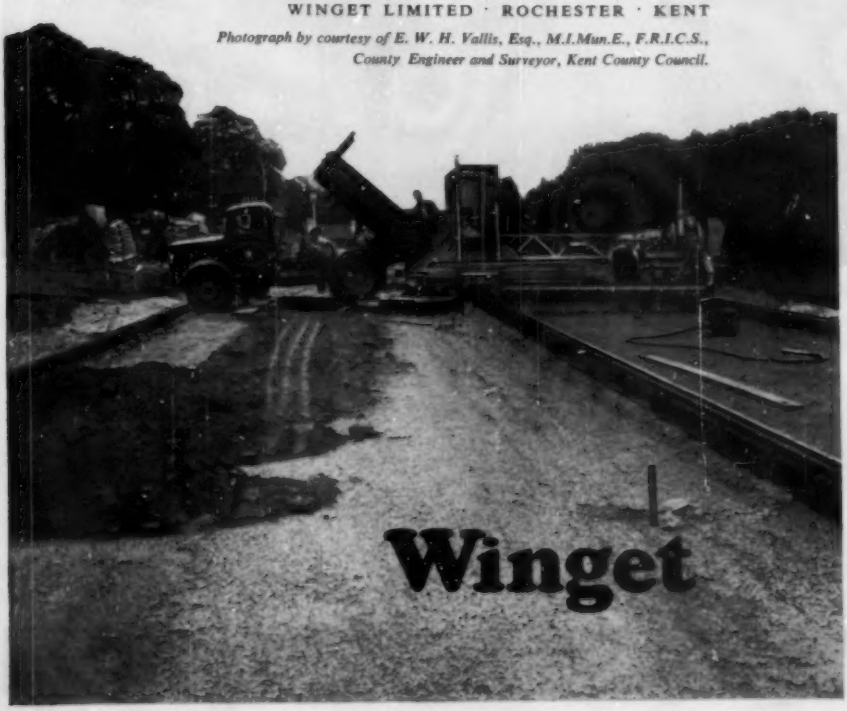
THE BRITISH STEEL PILING COMPANY LIMITED
10 HAYMARKET, LONDON S.W.1

New concrete road construction technique

The first Winget-Vibrocon B.U. 52 Concrete Spreading Machine was ordered by the Kent County Council (on the recommendation of the Road Research Laboratory and in conjunction with the Ministry of Transport and Civil Aviation) for use on the construction of the Ashford By-Pass. This picture, taken on a trial run at Potter's Corner, Hothfield, half a mile distant, shows the machine at work. Here, concrete is supplied by a battery of three Winget 10 HTH Hydraulically Operated Weigh Batching Tilting Drum Mixers feeding concrete to high loaders, which in turn charge a tipping lorry sited at the side of the spreader. The Winget-Vibrocon B.U. 52 Spreading Machine not only travels along the formwork spreading low-slump concrete with the smallest possible fall (to prevent pre-compaction and segregation), but gives accurate control of the depth of the spread carpet of concrete. The machine is powered by Diesel Electric Engine and has hydraulic control for varying the carpet thickness. Only one operator is required, and when it is necessary to remove the machine to another site, it can be telescoped to a size suitable for movement on public roads, and fitted with pneumatic tyred wheel assemblies. (Note Winget 'Vibrocon' Poker Vibrator in front of spreader.)

WINGET LIMITED · ROCHESTER · KENT

Photograph by courtesy of E. W. H. Vallis, Esq., M.I.Mun.E., F.R.I.C.S., County Engineer and Surveyor, Kent County Council.



CDC

Specialist manufacturers and designers of pre-stressed and pre-cast concrete structural components. Our products were used on the following contracts:—

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Consulting Engineer: A. E. Beer, Esq., E.R.D., A.C.G.I., A.M.I.C.E., M.I.Struct.E., M.Cons.E.

•

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Consulting Engineer: A. E. Beer, Esq., E.R.D., A.C.G.I., A.M.I.C.E., M.I.Struct.E., M.Cons.E.

An Advisory Service for scheme proposals and cost is readily available

CONCRETE DEVELOPMENT CO. LTD.

THORNEY LANE • IVER • BUCKS • TEL: IVER 1131

YGA 63

New Roads on the Continent.

A REPORT issued by the Roads Campaign Council gives some details of the new roads built in Germany since the war and now under construction. It is stated that in Western Germany 1300 miles of motor roads were built before the war, and a further 1245 miles have now been planned. Work started last year on 375 miles, which are to be completed by 1961 at an average cost of £375,000 per mile. These roads are restricted to use by motor vehicles. The minimum speed limit is 25 miles per hour, and there is no maximum speed limit. Vehicles are permitted to stop only on continuous strips beside the carriageway provided for this purpose. It is claimed that on this type of road there are only one-third as many accidents as on other roads with similar traffic, that the average speed of cars is 53 miles an hour compared with 31 miles per hour, and that the operating cost of vehicles is reduced by about one-third. Gradients are not more than 1 in 25. The latest machines for making concrete roads complete each day about 250 yd. of road 24 ft. wide, that is half the width of the carriageway.

A Pension Scheme for Engineers.

THE Engineers' Guild announces that it proposes to start a pension scheme for members and associate members of the Institutions of Civil, Mechanical and Electrical Engineers that will provide a continuous arrangement whether or not the member of the scheme changes his employment. The scheme will be available to self-employed as well as to employed engineers, and it is expected that it will be started in the autumn of this year.

A New Tipping Body.

A TIPPING body that can be mounted on an ordinary lorry chassis consists in the main of two lifting arms actuated by hydraulic cylinders situated longitudinally along the sides of the chassis. With these lifting arms a variety of equipment can be lifted from the ground on to the chassis and lowered to the ground. A skip can also be hinged at the back and tipped by the rearward motion of the pistons.

The chassis carrying the skip includes two jacks at the rear end, by means of which heavy side loads can also be lifted on to, and lowered from, the back of the vehicle. The equipment is made by F. X. Meiller, of Munich. *Fig.* 1 shows a vehicle with the skip in position, *Fig.* 2 shows the skip in the unloading position, and *Fig.* 3 shows the skip in the lowered position.

Fig. 1.

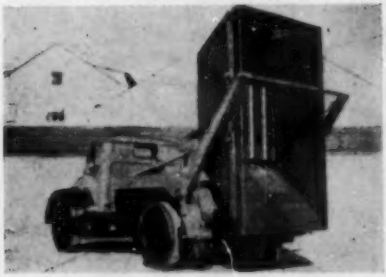

Fig. 2.

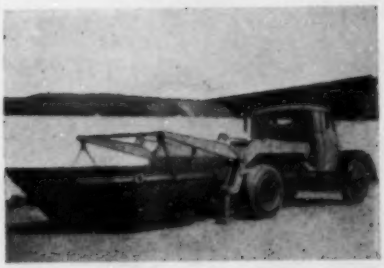

Fig. 3.

Improvement of the Great North Road.

WORK is to start soon on the improvement of the Great North Road between Alconbury Hill and Woolpack cross roads, Huntingdonshire, at a cost of about £300,000. The scheme will provide two carriageways each 24 ft. wide, and about one-half of one of the carriageways will be used for experimental work. More than a mile will be constructed in concrete, and in the remainder various types of "flexible" construction will be used with different kinds of surfacings. The scheme has been designed and will be supervised by the Huntingdonshire County Council.

Sinderby Bridge, Yorkshire, and its approaches will also be improved at a cost of about £190,000, over a distance of about a mile. The scheme includes strengthening and widening the present bridge over the Ripon-Northallerton railway and the construction of a bridge to carry the A1 road over the B6267 road. Both bridges will be built of steel by the direct-labour organisation of the Yorkshire County Council.

New Road in Derbyshire.

WORK has started on a new road 2¾ miles long to by-pass the village of Borrowash, Derbyshire, at a cost of £255,000. The contractors are Messrs. Gee, Walker & Slater, Ltd.

Change of Address.

THE address of Stic B Paint Sales, Ltd., is now 99 Wandsworth Road, London, S.W.8 (Telephone Reliance 5566).

MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 4d. a word : minimum, 7s. 6d. Situations Vacant, 5d. a word : minimum, 10s. Other miscellaneous advertisements, 5d. a word : 10s. minimum. Displayed advertisements, 35s. per column inch. Box number 1s. extra.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT.

SITUATIONS VACANT. Senior reinforced concrete designers wanted by leading reinforced concrete engineers and contractors. Must be fully conversant with Code of Practice, L.C.C. Bye-Laws, and able to design light-framed structures from estimating stage to final details. Five-days' week. Pension scheme. Progressive position. Starting salary from £900 upwards according to ability. This year's holiday arrangements honoured. Juniors also required, similar conditions. Write BOX 4172, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Assistant structural engineers required with experience of reinforced concrete design. Experience of precast techniques advantageous. Salary according to experience and qualifications. Apply in writing to TECHNICAL MANAGER, THE SCOTTISH CONSTRUCTION CO., LTD., Sighthill Industrial Estate, Edinburgh.

SITUATION VACANT. Consulting structural and civil engineers require an engineering assistant with at least 5 years' office experience since Graduateship and National Service, to supervise the design and detailing of reinforced concrete structural frameworks and foundations. Salary £750–£900 according to age, qualifications and experience. Superannuation scheme, and luncheon vouchers. Apply ANDREWS, KENT & STONE, 60–66 Wardour Street, London, W.1.

SITUATION VACANT. Experienced reinforced concrete detailer-draughtsman required by ROM RIVER CO., LTD. Permanent and progressive post. 36½-hours' week. Superannuation scheme. Salary according to age and experience. Existing holiday arrangements honoured. Telephone Euston 7814.

SITUATION VACANT. W. & C. FRENCH, LTD., urgently require a detailer. Essential that person selected should be able to detail reinforced concrete structures quickly and accurately from sketch designs or calculations. Write, stating age, experience, and salary requirements, to PERSONNEL MANAGER, 50 Epping New Road, Buckhurst Hill, Essex.

SITUATIONS VACANT. Experienced reinforced concrete detailers required. Prospect of contemporary design experience. Good salaries. Five-days' week. JOHN DE BREMAEKER & PARTNERS, 3 Southampton Place, London, W.C.1. Chancery 3785.

SITUATION VACANT. Designer-draughtsman required for an expanding firm of reinforced concrete engineering contractors in the Midlands. Varied and interesting work in insitu and precast types of construction, with excellent prospects for a man able to take responsibility. Five-days' week and contributory pension scheme. Assistance with housing will be given if required. Reply, giving full details, to STRUCTURAL ENGINEER, BEECHAM BUILDINGS, Ltd., Shipston-on-Stour, Warwickshire.

SITUATION VACANT. Reinforced concrete detailer-draughtsman for work in London office. Five-days' week, non-contributory pension scheme after three years' service. Progressive position. Applicants must be over National Service age or have obtained exemption. Three to four years' experience with reinforced concrete specialists preferred. Write, giving particulars, to THE SPENCER WIRE CO. (DEVELOPMENTS), LTD., 53 Victoria Street, Westminster, S.W.1.

SITUATION VACANT. Senior designer required for varied and interesting reinforced concrete and civil engineering work with Manchester firm of engineers and contractors. Good prospects for right man. BOX 4310, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

COSTAIN CONCRETE COMPANY

require the services of a

SALES REPRESENTATIVE

for the marketing of Stahlton Flooring. Applicants must have a thorough knowledge of the industry. Salary of secondary importance in obtaining the right person.

Write, giving full details of experience, to :

The Chief Personnel Officer, Costain Concrete Co. Ltd., 111 Westminster Bridge Road, London, S.E.1.

REINFORCED CONCRETE DESIGNERS

DETAILERS & DRAUGHTSMEN

are invited to apply for vacancies in the Keynsham and Bristol offices of Square Grip Reinforcement Co., Ltd., Keynsham, Bristol. Opportunity to work on variety of structures. Five-days' week, modern offices. Previous experience essential for senior posts, but consideration given to other suitable draughtsmen. Good salaries with pension and profit-sharing schemes.

SURREY COUNTY COUNCIL

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1. ASSISTANT STRUCTURAL ENGINEER GRADE IV–VI, minimum £710, maximum £1,080 p.a., plus £30 London Allowance.
2. STRUCTURAL ENGINEERING ASSISTANT GRADE I–III, minimum £530, maximum £765 p.a., plus L.A.

Salary range of appointment and commencing salary will depend on experience and qualifications.

Full details, present salary, and 3 copy testimonials to COUNTY ARCHITECT, County Hall, Kingston, as soon as possible.

LONDON COUNTY COUNCIL

ARCHITECT'S DEPARTMENT

Vacancies for Engineering Assistants (up to £818) and Engineer Grade III (up to £987) in the Structural Engineering Division. Work includes steelwork and reinforced concrete design and detailing for Council's buildings. Particulars and application forms from ARCHITECT (AR/EK/SE/3), The County Hall, London, S.E.1. (1278.)

THE TRUSSED CONCRETE STEEL COMPANY LIMITED

ENGINEERING DEPARTMENT

Applications are invited from Reinforced Concrete Designers and Detailers for work in the Company's Head Office in London (near Waterloo Station), and its Harlow, Birmingham, Glasgow, and Manchester Design Offices. Five-days' week. Pension and Profit Sharing Schemes are in operation. Please apply, giving full details of age, education and previous experience, to the ENGINEERING MANAGER, Truscon House, 35–41 Lower Marsh, London, S.E.1.

(*Continued on next page.*)

MISCELLANEOUS ADVERTISEMENTS.
(Continued from previous page.)

SITUATION VACANT. THE STANTON IRONWORKS CO. LTD., near Nottingham, has a vacancy for a senior designer-draughtsman on its concrete plants. The position is permanent, pensionable, and offers excellent opportunities for advancement. The work will comprise design of precast, prestressed, and reinforced concrete products and ancillary equipment, estimating, etc. Applicants should be Graduates of the Institution of Civil or Mechanical Engineers, or hold equivalent qualifications. Write in confidence to the Staffing Officer.

SITUATION VACANT. Civil engineer, London and Midlands. Experienced in design and detailing reinforced concrete. Age 28–38, with usual professional qualifications. Salary range, according to abilities and age, £1250 to £1750. Non-contributory staff fund. Write in confidence, with full career particulars, to BOX 4306, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. A.M.I.Mech.E. with some electrical and building constructional experience, or A.M.I.C.E. with mechanical and electrical experience, required for interesting position in the Middle East. Age preferably 30–35. Basic salary according to experience, plus free furnished quarters and living allowance. Apply, with full details, to BOX 4307, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Situation vacant with consulting engineers in Central London for a reinforced concrete structural engineer of experience to assume responsibility of drawing office. Good salary and five-days' week, with permanent position to suitable applicant. Write, stating age, experience, and salary required, to BOX 4311, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Senior and intermediate structural designer-detailers required by consulting engineers. Senior men will be expected to take over complete projects from the design stage, and be experienced in reinforced concrete. Salary according to qualifications and experience. Luncheon vouchers, pension scheme, and five-days' week. THE CONISTON COMPANY, Eagle House, High Street, Wimbledon, S.W.19.

SITUATION VACANT. The B.R.C. Engineering Co., Ltd., require a representative, age about 25 years, with a knowledge of reinforced concrete construction. Applications to SALES DIRECTOR, THE B.R.C. ENGINEERING CO. LTD., Stafford.

SITUATIONS VACANT. Reinforced concrete detailers required by small firm of consulting engineers. Five-days' week. Salary according to age and experience. THE WELLESLEY CO., 126 Brixton Hill, London, S.W.2. Tulse Hill 9264.

SITUATIONS VACANT. Draughtsmen, detailers, and assistant section leader required, with experience of reinforced concrete, precast or insitu and/or general building construction, in the flooring department of our Bristol office. Five-days' week. Superannuation scheme. Please reply, stating age and experience, to THE TRUSSED CONCRETE STEEL CO. LTD., 17 Orchard Street, Bristol, 1.

OLD-ESTABLISHED BUILDING TRADE SPECIALISTS

require for their London H.O.
(Victoria District)

SENIOR DESIGNER/ DRAUGHTSMAN

experienced in all aspects of R.C. Frames and Building Construction and capable of taking charge of Drawing Office.

The position is permanent, progressive, and pensionable. Please write, giving full details of experience and stating salary required, to Box 4300, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

REINFORCED CONCRETE
PRESTRESSED CONCRETE

Senior designers are invited to apply for positions in the Project Department in our Manchester office. Competence in structural analysis and enthusiasm for keeping up-to-date with the latest developments are essential requirements ; a knowledge of quantities would be an advantage.

Design-detailers are required in the Drawing Offices in Nottingham and Manchester. Structural steelwork designers who would like to extend their experience to reinforced concrete will be considered.

The work covers an interesting variety of reinforced concrete and prestressed concrete commercial and industrial structures. It offers considerable scope for ingenuity, particularly in large-scale precast construction. Salaries range to £1,200 per year and consideration would be given to assistance in removal expenses. Good working conditions include three weeks' annual holiday, pension scheme, and a five-days' week : this year's holiday arrangements will be met.

MATTHEWS & MUMBY, LTD.

129 Stockport Road, Manchester, 12

Chief Engineer: D. D. Matthews, M.A., D.Eng., M.I.C.E., M.I.Struct.E.

SALES REPRESENTATIVE

required by a large firm of structural flooring contractors. Knowledge of flooring industry and contacts with Consulting Engineers and Architects essential.

Good salary and pension scheme in operation. Car supplied by Company.

Apply in writing, stating experience, to Box 4308, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

LIVERSEDGE

CONSULTING STRUCTURAL ENGINEERS

require

Designer-detailers and draughtsmen experienced in all types of reinforced concrete work. Structural steelwork experience an advantage. Pleasant conditions, good salaries and prospects for suitable applicants.

Details to

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Opportunity for Reinforced Concrete Designers...

to join the London staff of BRC

There are opportunities for Reinforced Concrete Designers in their New London Office at 54 Grosvenor Street, equipped with controlled heating and ventilation and canteen. Five day week — 37½ hours — Pension Fund. Salaries are reviewed annually. Designer-Detailers with good experience will be offered salaries of £750 to £950 per annum, and Detailers with some design experience, up to £750 per annum. They also have a few openings for Student Apprentices of good educational standard and for Students who have just completed the Higher National Certificate Course.

THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD

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M-W.813

SITUATION VACANT. Civil engineering draughtsman required for work in London office of large civil engineering contractors. Work of varied nature, with scope for initiative and advancement. Commencing salary £600–£800 depending on experience. Five-days' week and luncheon vouchers. Pension scheme operates. Box 4228, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Designers, draughtsmen-detailers in reinforced concrete urgently required by consulting engineers for design of multi-story buildings. Permanent positions. Interesting work. Good prospects. Write, stating experience, and salary required, to Box 4313, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. THE BRITISH PETROLEUM CO. LTD., have vacancies for civil engineering draughtsmen at head office in London, situated 5 minutes from Liverpool Street Station. Applicants, age 22–30, should hold H.N.C. (Civil) or equivalent, and have at least three years' drawing office experience, with some site experience on foundations and other civil engineering work. The work may involve occasional visits to company's installations in the U.K. and overseas. Salary according to age and experience. Non-contributory pension scheme. Five-days' week. Excellent luncheon club. Write, giving full details, quoting H-10000, to Box 9218, c/o 191 Gresham House, London, E.C.2.

SITUATIONS VACANT. Civil engineering draughtsmen required in London on consulting side. Previous experience in this work not essential if good progress has been made with ONC/HNC studies. Several vacancies available due to extension of staff would offer opportunities both experience and financial. Details of experience and studies, age, etc., please, to Box 4312, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. E. J. COOK & CO. (ENGINEERS), LTD., require an experienced detailer for reinforced concrete structures. Interesting work and good prospects for competent man. Five-days' week, pension scheme and luncheon vouchers. Apply to 34 South Side, Clapham Common, London, S.W.4.

SITUATIONS VACANT. Checker, reinforced concrete, required for consulting engineers' office. Applicants should have had at least 10 to 16 years' experience in a detailing office. Salary according to qualifications and experience. Luncheon vouchers, pension scheme, and five-days' week. THE CONISTON COMPANY, Eagle House, High Street, Wimbledon, S.W.19.

COVENTRY CORPORATION

require

(*a*) DESIGN DRAUGHTSMAN (Structural Engineering) APT.VI. (£880–£1080); experience of reinforced concrete design of engineering and building structures essential. Knowledge of soil mechanics and structural engineering in other materials desirable.

(*b*) ASSISTANT STRUCTURAL ENGINEER (Building Plans)—Special grade (£690–£840). £26 Local Award paid in addition to salaries up to £795. Knowledge of all types building construction and materials to bye-laws requirements essential.

Minimum qualifications expected—final examination of Institution Civil Engineers or Institution Structural Engineers. Application forms from CITY ENGINEER, Council House, Coventry, returnable by 21st September, 1956.

LONDON COUNTY COUNCIL

ARCHITECT'S DEPARTMENT

Vacancies for STRUCTURAL ENGINEERS in the District Surveyors' Service: Engineering Assistants (up to £817). Grade III Engineers (up to £987), with commencing salaries according to qualifications and experience. Further particulars and application form obtainable from the Architect (AR/EK/DS/3), County Hall, London, S.E.1. 1357.

(*Continued on next page.*)

MISCELLANEOUS ADVERTISEMENTS

(*Continued from previous page.*)

SITUATIONS VACANT. Specialist reinforced concrete firm requires designers and draughtsmen all grades. Half-yearly bonuses, luncheon vouchers, etc. Write, giving experience and stating salary required, to The Reinforced Concrete Steel Co. Ltd., 54 Victoria Street, London, S.W.1.

SITUATIONS VACANT. Consulting engineers require detailers for interesting reinforced and prestressed concrete work. Salaries £500 £700 per annum according to experience. Chamberlain & Partner, 20 Woods Mews, London, W.1. Mayfair 5859.

MANAGEMENT SELECTION LIMITED

invite applications for the position of

SENIOR ENGINEER

in the flooring division of large building and civil engineering company. Responsible for technical liaison with clients and contractors, design and technical supervision of sites in London and Home Counties. Candidates must be qualified civil or structural engineers and have wide experience in design and construction of all types of reinforced and prestressed concrete. Salary up to £1150. Pension. Car or car allowance. Probably age 30 to 40. Please write in confidence to R. A. Denerley, Management Selection Ltd., SE150, 8 Clarges Street, London, W.1.

YORKSHIRE ELECTRICITY BOARD

HEAD OFFICE

Civil Engineering Draughtsman

Applicants should have good experience in preparing detailed drawings for structural and civil engineering work, with particular emphasis on reinforced concrete. Knowledge and experience of reinforced concrete design are also desired.

Salary—N.J.B. Schedule D Grade 4 £810/20/910 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees, should be forwarded to The Secretary, Yorkshire Electricity Board, Wetherby Road, Scarcroft, near Leeds, not later than September 26.

STRUCTURAL ENGINEERS R.C. DETAILERS

required by

GEORGE WIMPEY & CO. LIMITED

for permanent appointments in Hammersmith.

5-days' week, 9.0 to 5.30. Staff Restaurant.

Applications to

ESTABLISHMENT OFFICER,
27, Hammersmith Grove, London, W.6.
Ref. R.112.D.

SITUATION VACANT. Deputy to works manager. An opportunity for an energetic young man with experience of factory administration and planning. The works manager is in charge of a group of factories centered at Trafford Park, Manchester, making precast concrete products, pressed and welded steel products, bar-bending, etc. Experience in this field is not vital. An attractive starting salary is envisaged. Applications, with details of age, experience, and salary, should be sent to the Secretary, The Trussed Concrete Steel Co. Ltd., 35 41, Lower Marsh, London, S.E.1.

SITUATIONS VACANT. Assistant civil engineers required on design side in London by Westminster consultants. Experience of power station or dock work advantageous. Salary, about £800 upwards, would be varied according to qualifications and experience. Box 4315, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Civil engineering assistants (design) wanted by consulting engineers in London. Those carrying H.N.C. studies will have opportunities to cover A.M.I.C.E. requirements as to site experience. Salary will be in relation to experience of the order of £600 upwards. Usual details in first instance, please, to Box 4317, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Design assistant required by Westminster consultants. Good structural steel and/or reinforced concrete experience essential. Ability to lead through schemes under direction of senior engineer indicates it is a senior-capacity post for which salary will be based on qualifications and experience. Box 4316, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Monsanto Chemicals Ltd., require the services of technically-qualified draughtsmen experienced in the design and detailing of reinforced concrete structures associated with chemical manufacturing plant. The posts are permanent, and a non-contributory pension scheme and life assurance are in operation. Five days' week, staff restaurant. Application should be sent in writing, giving full details of age, education, training, and experience, to the Chief Personnel Officer, Monsanto Chemicals Ltd., Monsanto House, 10-18 Victoria Street, London, S.W.1.

NATIONAL COAL BOARD NORTH EASTERN DIVISION

Applications are invited for the vacancy of Civil Engineer in No. 7 (Wakefield) Area, Newton Hill, Wakefield. Salary range £1,250 £2,000.

Candidates should have had professional experience in Civil Engineering and should be Corporate Members of the Institute of Civil Engineers. Consideration will be given to Corporate Members of the Institution of Structural Engineers with adequate Civil Engineering experience. Experience in projects through the various stages from inception to completion and of contract documents and administration of contracts is desirable. The duties will include giving advice on the Civil/Structural Engineering aspects of surface installations, assisting with the planning of reconstruction works and superintending works during construction.

Applications, stating age, qualifications and experience, should be forwarded to the Area Staff Manager, National Coal Board, No. 7 (Wakefield) Area, North Eastern Division, P.O. Box 13, Newton Hill, Wakefield, to arrive not later than the *22nd September, 1956*.

SITUATION WANTED.

SITUATION WANTED. Structural engineer, six years' experience, desires responsible position where two years' recent architectural engineering in U.S.A. no handicap. Box 4309, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

PARTNERSHIP.

PARTNERSHIP. Well-qualified English chartered civil engineer, resident in Ireland, requires connection with firm of consultants with view to partnership or take-over. Structural work, water engineering, and interest in heating. Capital available. In confidence to Box 4314, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

FOR HIRE.

FOR HIRE. Lattice steel erection masts (light and heavy), 30 ft. to 150 ft. high, for immediate hire. Bellman's, 21 Hobart House, Grosvenor Place, London, S.W.1.

STONE ★ COURT AGGREGATES

General View of Plant at Richmansworth.

ONE OF OUR MODERN CONCRETE AGGREGATES PLANTS

First-Class Washed graded concrete aggregates, and shingles for road dressing, coupled with efficient delivery, are at the service of contractors and Municipal Authorities in London, Berks, Bucks, Herts, and Middlesex Areas.

Our products include Washed Sharp Sand, all sizes of shingles, from 3/16" up to 2", either crushed or natural.

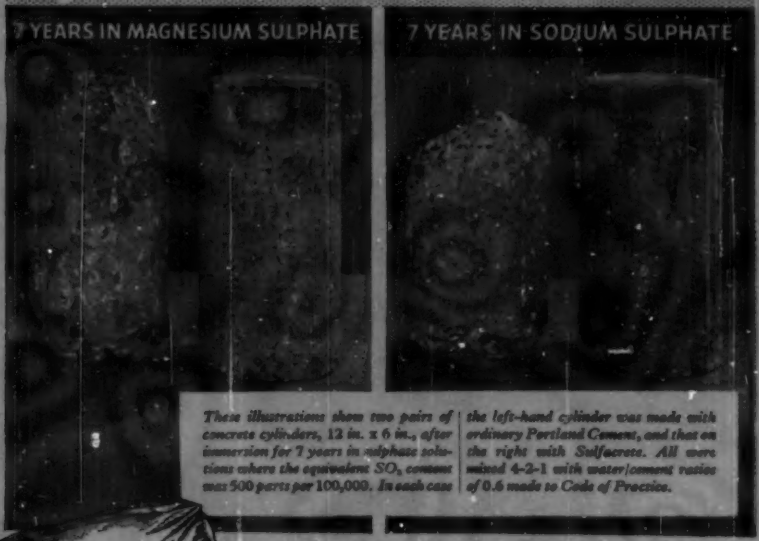
Special Specifications made to order.

STONE COURT BALLAST CO. LTD.

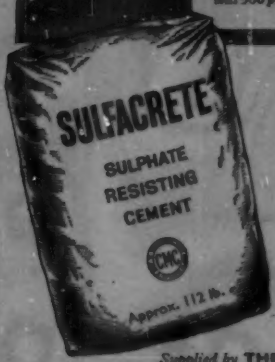
PORTLAND HOUSE, TOTHILL ST., WESTMINSTER, S.W.1

Telephone: Abbey 3456.

See how SULFACRETE Sulphate Resisting Cement passed searching 7 year test



These illustrations show two pairs of concrete cylinders, 12 in. x 6 in., after immersion for 7 years in sulphate solutions where the equivalent SO_3 content was 500 parts per 100,000. In each case the left-hand cylinder was made with ordinary Portland Cement, and that on the right with Sulfacrete. All were mixed 4-2-1 with water/cement ratios of 0.6 made to Code of Practice.



THESE tests prove conclusively the value of using Sulfacrete, formerly known as Blue Circle Sulphate Resisting Cement, for concrete which is liable to the destructive action of soluble sulphates. The protective value of the Sulfacrete has been proved by its successful use for sewerage schemes, pipe lines, piles and foundations.

Supplied by THE CEMENT MARKETING COMPANY LTD.
Portland House, Tothill Street, London, S.W.1.
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THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD., Penarth, Glam.

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